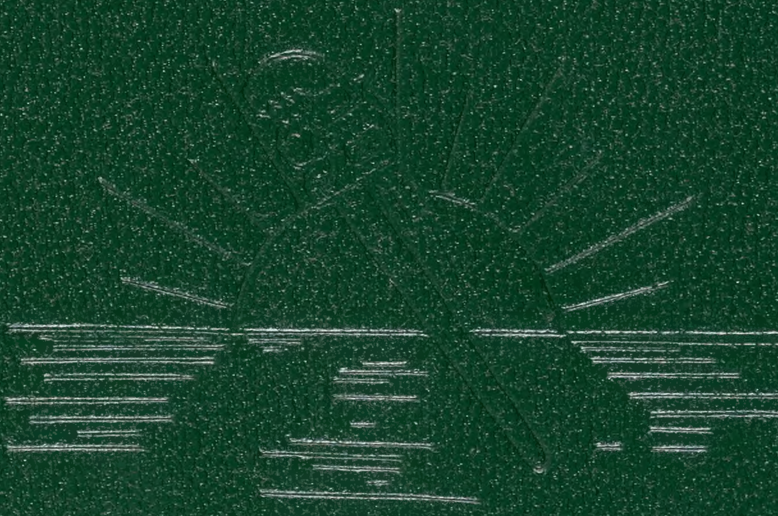
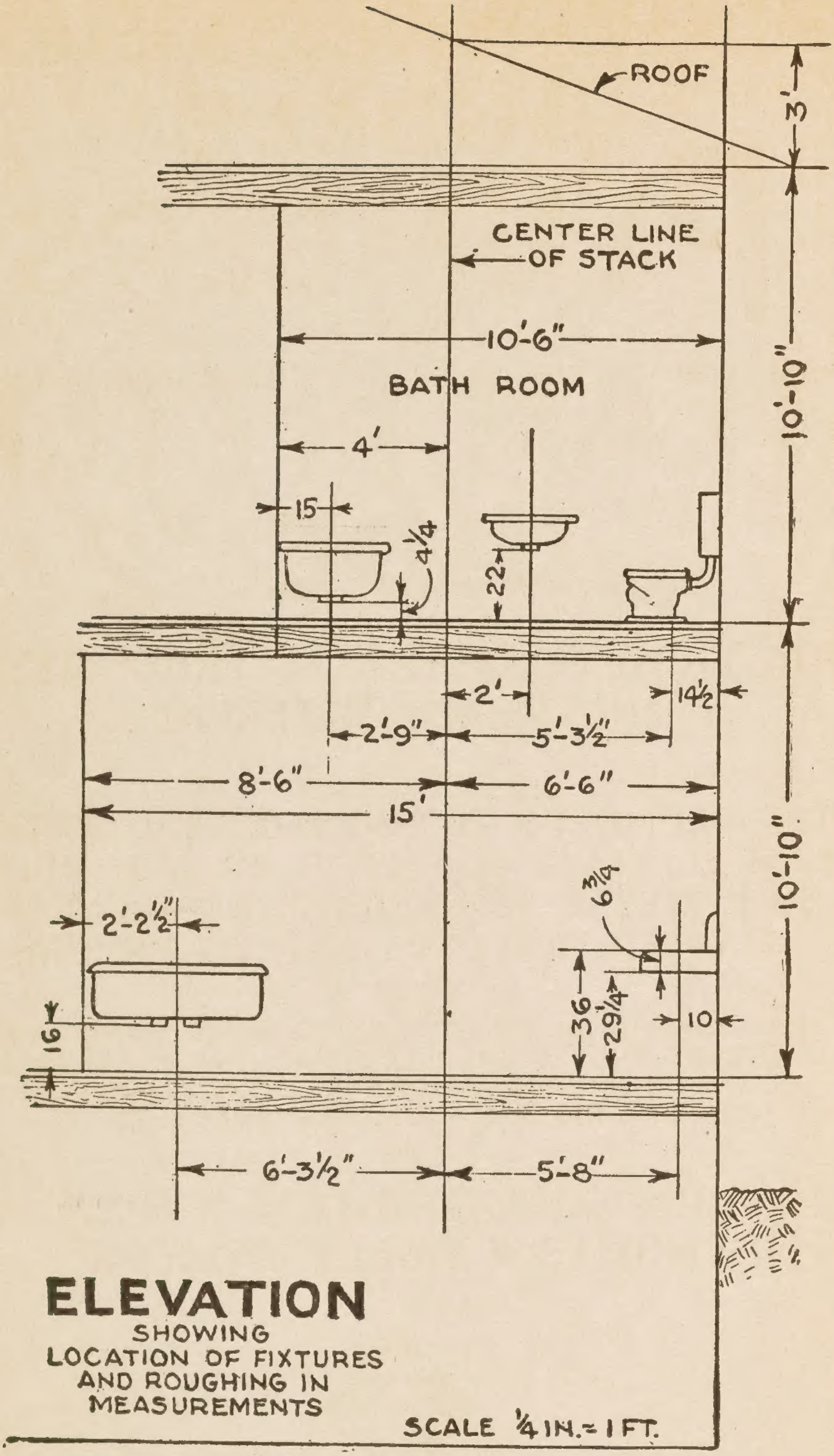
AUDELS PLUMBERS AND STEAM FITTERS GUIDE #2





Assembly of Fixtures in Small House.

Various systems of piping for the installation shown above are given in detail in the Chapter on ***Roughing In.***

"BY HAMMER AND HAND ALL THINGS DO STAND"

AUDELS PLUMBERS AND STEAM FITTERS GUIDE #2

A PRACTICAL ILLUSTRATED TRADE ASSISTANT AND READY REFERENCE

FOR

MASTER PLUMBERS, JOURNEYMEN AND APPRENTICES
STEAM FITTERS, GAS FITTERS AND HELPERS,
SHEET METAL WORKERS AND DRAUGHTSMEN
MASTER BUILDERS AND ENGINEERS

EXPLAINING IN PRACTICAL CONCISE LANGUAGE
AND BY WELL DONE ILLUSTRATIONS, DIAGRAMS,
CHARTS GRAPHS AND PICTURES THE PRINCIPLES
OF MODERN PLUMBING PRACTICE

BY

FRANK D. GRAHAM - *CHIEF*
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Foreword

These Guides give first hand reliable practical information in clear and concise form. They illustrate ***Plumbing*** in its many practical applications in the clearest and plainest manner and in a way not to discourage the searcher for practical plumbing knowledge, but to make an interesting, instructive and useful reference for all interested in any branch of plumbing.

In the prepartion of these Guides, the aim of the author has been to present the subject in ***the simplest possible manner,*** because no matter how well informed the reader may be, he absorbs the desired information much more readily when presented in simple, brief language, than he would when confronted with an unnecessary display of technicalities.

The aim throughout has been to simplify and give information on ***every phase of plumbing.***

Frank D. Graham.

OUTLINE OF CHAPTERS

READY REFERENCE INDEX
and
READERS' GUIDE

An hour with a book would have brought to your mind,
The secret that took the whole year to find;
The facts that you learned at enormous expense,
Were all on a library shelf to commence.

To the Reader and Student:

Read over this index occasionally and get the habit of looking for *unexpected information.* The ready reference index tells you on what pages to find the information sought for.

When you are interested and want information quickly on a problem in ***Plumbing,*** if you have the habit of consulting these ***Plumbers' Guides*** they will answer your problem.

Learn to use the index; all subjects covered are listed under their proper headings; it is also suggested to look up closely allied subjects for side lights on your problems.

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CHAPTER 112

Elements of Sanitation

1. Water Supply

The word sanitation is defined as *the devising and applying of measures for preserving and promoting public health; the removal or neutralization of elements injurious to health; the practical application of sanitary sciences.*

It is the practical work of the plumber to "devise and apply measures" for the "removal or neutralization of elements injurious to health," and accordingly the health of the occupants of a building depends upon the efficiency of the plumber's work. Because of this, plumbers are required to secure a license, which is a wise protection for the public.

The essential elements of sanitation are:

1. Water supply.
   a. Cold water.
   b. Hot water.
2. Drainage.
3. Sewage disposal.

and considering the subject broadly, there is also included:

3. Heating.
4. Ventilation.
5. Refrigeration.
6. Illuminating gas supply.

Of all the elements the one most vitally important is ***drainage.***

Not only must the work of installing the drainage system be properly executed, but the system itself should be designed according to correct principles, otherwise foul gases generated from decomposing matter will escape and endanger the health of the occupants.

Owing to the importance of the subject and extended treatment necessary to explain properly the vital basic principles, several chapters are given to their presentation.

The present chapter treats of the various systems of water supply.

The aim of the author in these chapters is to explain the working of every plumbing device without going into their mechanical construction. By thus considering "*how it works*" without regard to its *mechanical construction*, the mind of the reader is not diverted, hence he can concentrate upon the items the author is attempting to explain and so much more easily master the subject than when burdened with a lot of mechanical details not necessary to understand how it works. Mechanical construction is later considered in its proper place.

Cold Water Supply.—The sources from which water is obtained for domestic purposes are numerous, such as wells, springs, lakes, brooks, rainfall, etc. The method of getting the water to the point of supply gives rise to several systems, as:

1. Street pressure.
2. Gravity (tank).
3. Pneumatic.

Street Pressure System.—The source of supply of the street pressure system is the street main into which water is furnished under pressure by the City Water Company. A *service pipe* is run from the main to the dwelling and connects with the *supply pipe*, and from which are taken suitable branches which run to the various fixtures as shown in

fig. 6,554. Whereas this system is simple mechanically, it sometimes has disadvantages depending upon the pressure.

In cases where the pressure is excessive, the piping and fixtures are subjected to needless pressure, bringing heavy duty on the valves and tending to increase leakage; if too low or variable, the water will not flow to the outlets of upper floors, or the supply there will be very poor.

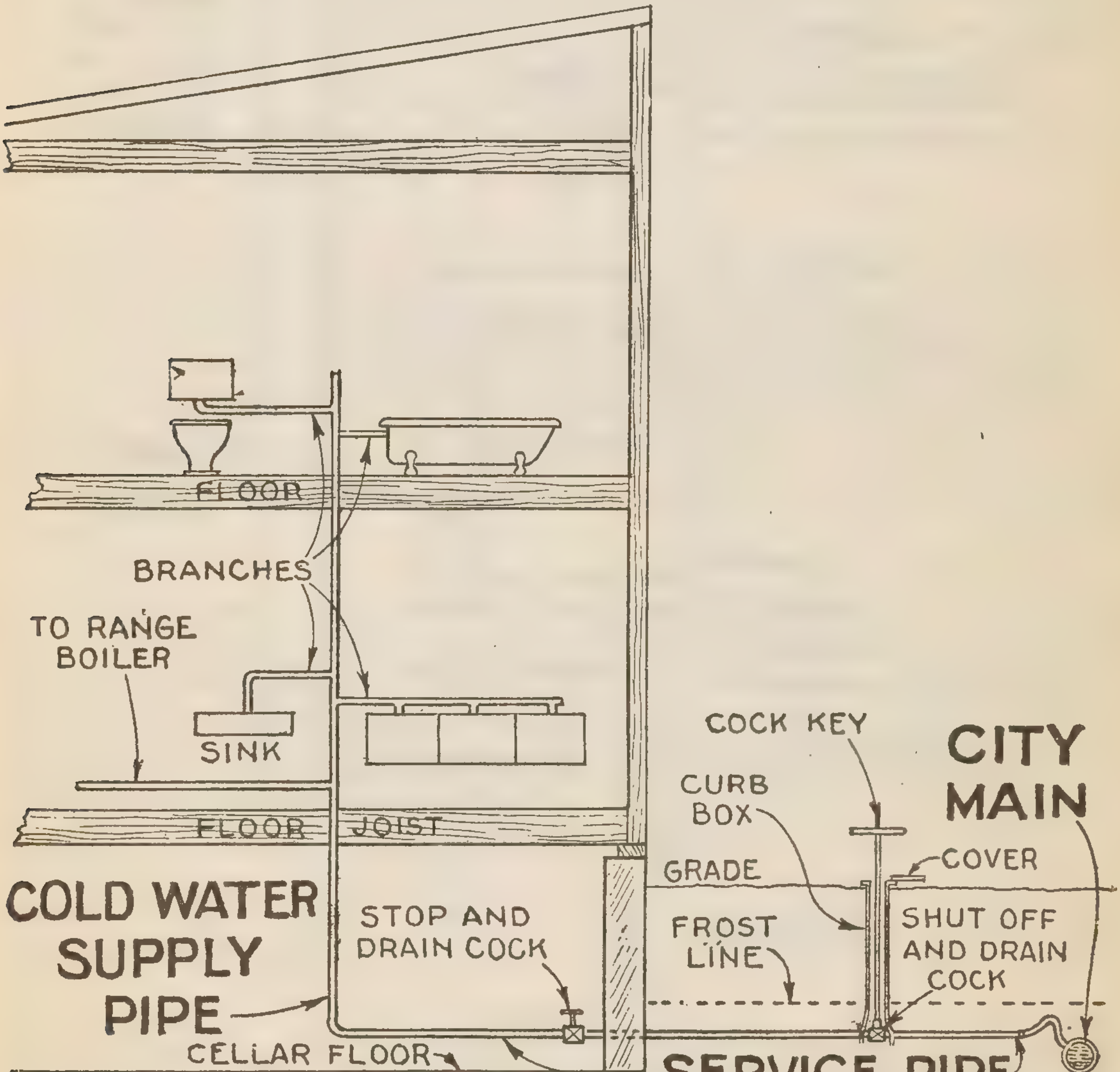


FIG 6,554.—Cold water supply piping 1, where water is taken from city main; ***street pressure system.***

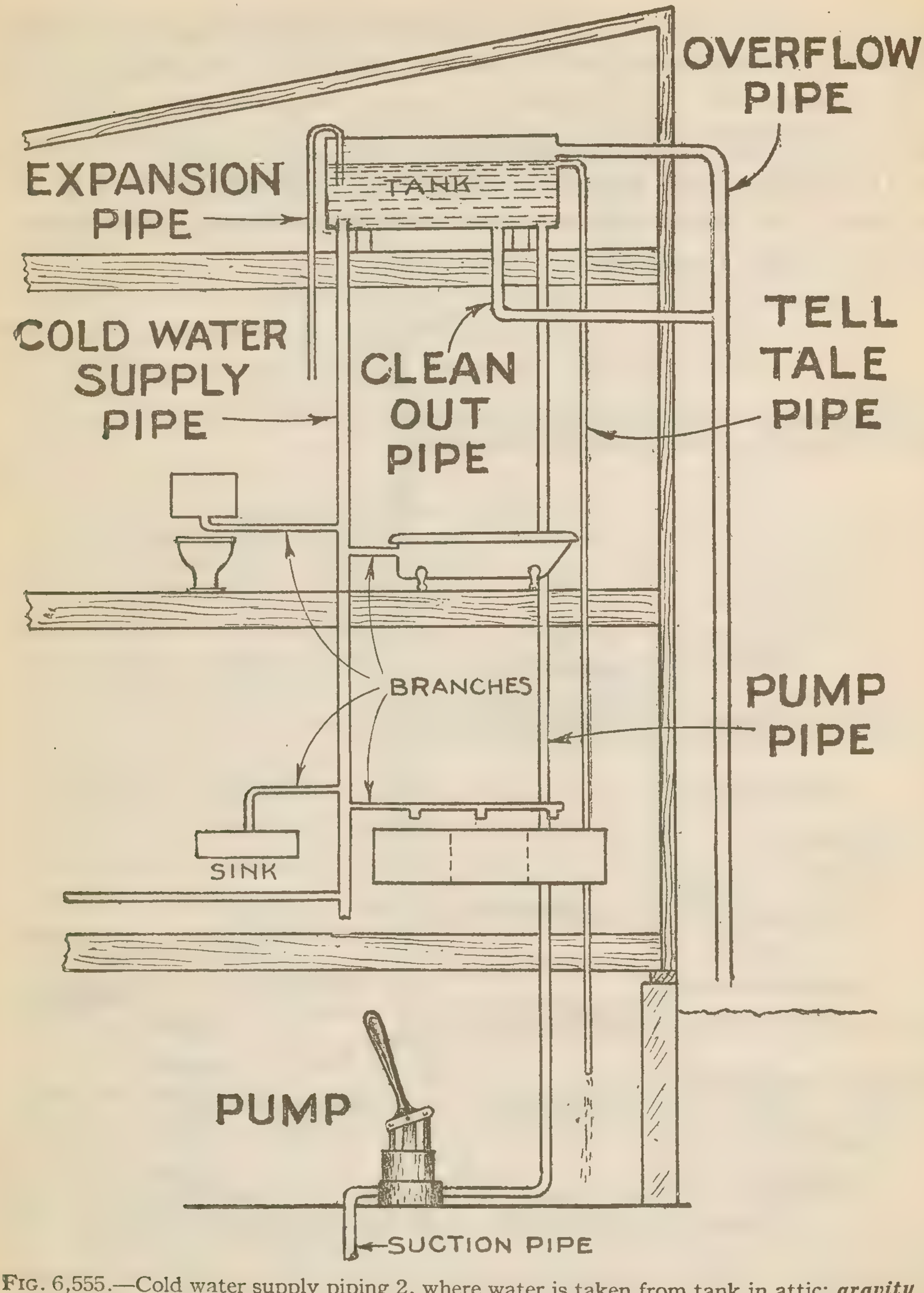


FIG. 6,555.—Cold water supply piping 2, where water is taken from tank in attic; ***gravity or tank system.***

Sometimes, when the city pressure is excessive, a reducing valve is placed on the supply pipe to protect the line and fittings from unnecessary pressure.

It should be understood that in any system, the installation must not only withstand the working pressure, but momentary shocks due to water hammer which is caused by the quick closing of faucets. Wrought pipe (commonly but erroneously known generally as "wrought iron pipe")* will stand enormous pressures and reducing valves are not necessary; lead pipe, however, is much weaker and the weight pipe used must be adequate for the working pressure.* Because of the enormous strain possible from water hammer and general deterioration from use, it is advisable to use pipe, which, when new, will require to burst it, a pressure of at least 20 times the working pressure.

Gravity or Tank System.—Where the city pressure is too low (or sometimes too high) and especially in isolated plants, the gravity or tank system is generally used. In this system a tank is placed in the top of the house and connected with the source of supply. Since the tank is higher than the outlets to fixtures, water will flow to the outlets by gravity as shown in fig. 6,555.

This system, while requiring the additional outlay for tank, has the advantage of providing storage for a quantity of water which gives a reserve supply during repairs to pump or street mains, and also of subjecting the system to a minimum and practically constant pressure. This feature is of practical value in the case of old lead pipe installations originally supplied by pump but later connected with city mains. In such case connection is made from the service pipe to top of tank using wrought pipe and regulating the supply to tank by a float valve as in fig. 6,557.

In suburban districts not having city water supply, and

*NOTE.—Because of the excessive cost of lead pipe, the weight pipe necessary to withstand the pressure should be carefully considered and specified in any contract or agreement, otherwise an unscrupulous plumber will install pipe too light, which will surely be a source of trouble later. This is one of the reasons why lead pipe has come into disfavor, and it is not a legitimate reason.

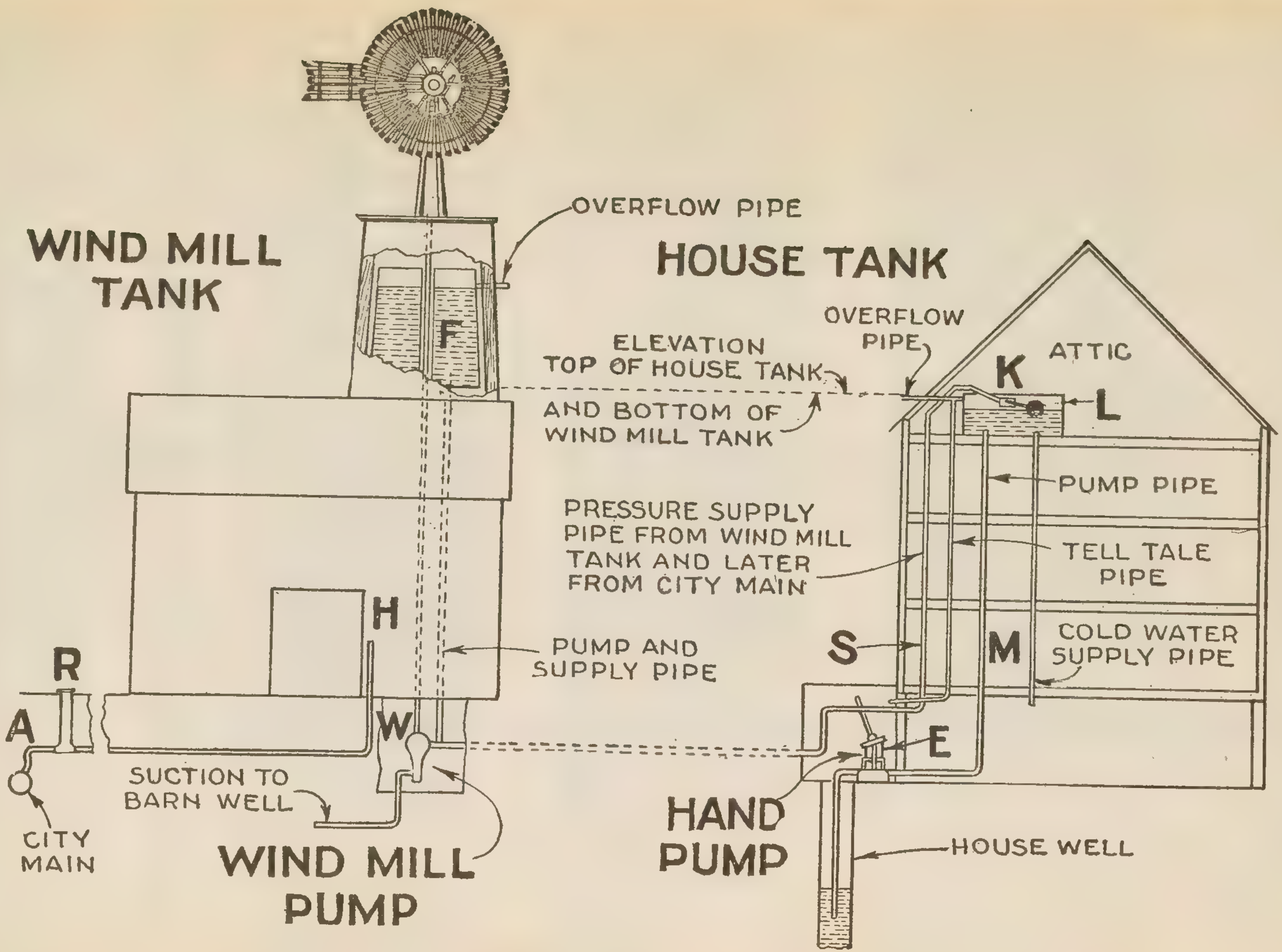


FIG. 6,556—Cold water supply as installed in the author's residence ***"Stornoway"*** near ***Sea Bright, N. J.***, illustrating how the tank system is adapted to changing conditions. **L**, house tank; **F**, wind mill tank; **M**, hand pump pipe; **S**, wind mill pump pipe; **E**, hand pump; **W**, wind mill pump; **H**, city connection; **R**, street shut off; **A** city main.

especially along the seashore and other exposed places favorable to winds, water is usually pumped by windmill power.

The cold water supply as installed in the author's residence at Sea Bright, N. J., will illustrate how the gravity system may be adapted to changing conditions. This installation is shown in fig. 6,556. The water was originally supplied to a tank L in the house by a hand pump E, which was very unsatisfactory, the supply inadequate and expensive. Later a wind mill was installed having a tank F, in the wind mill tower located

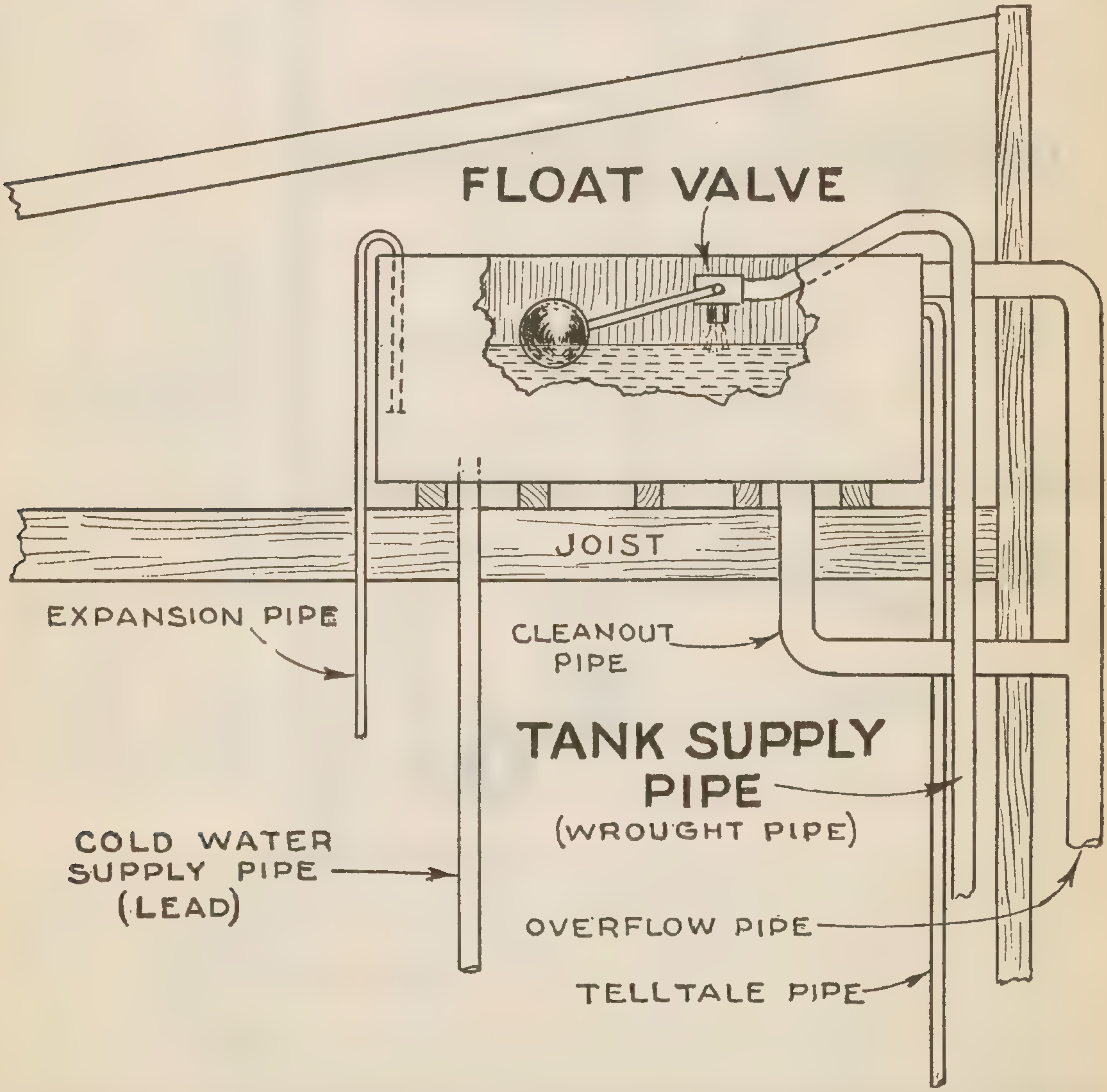
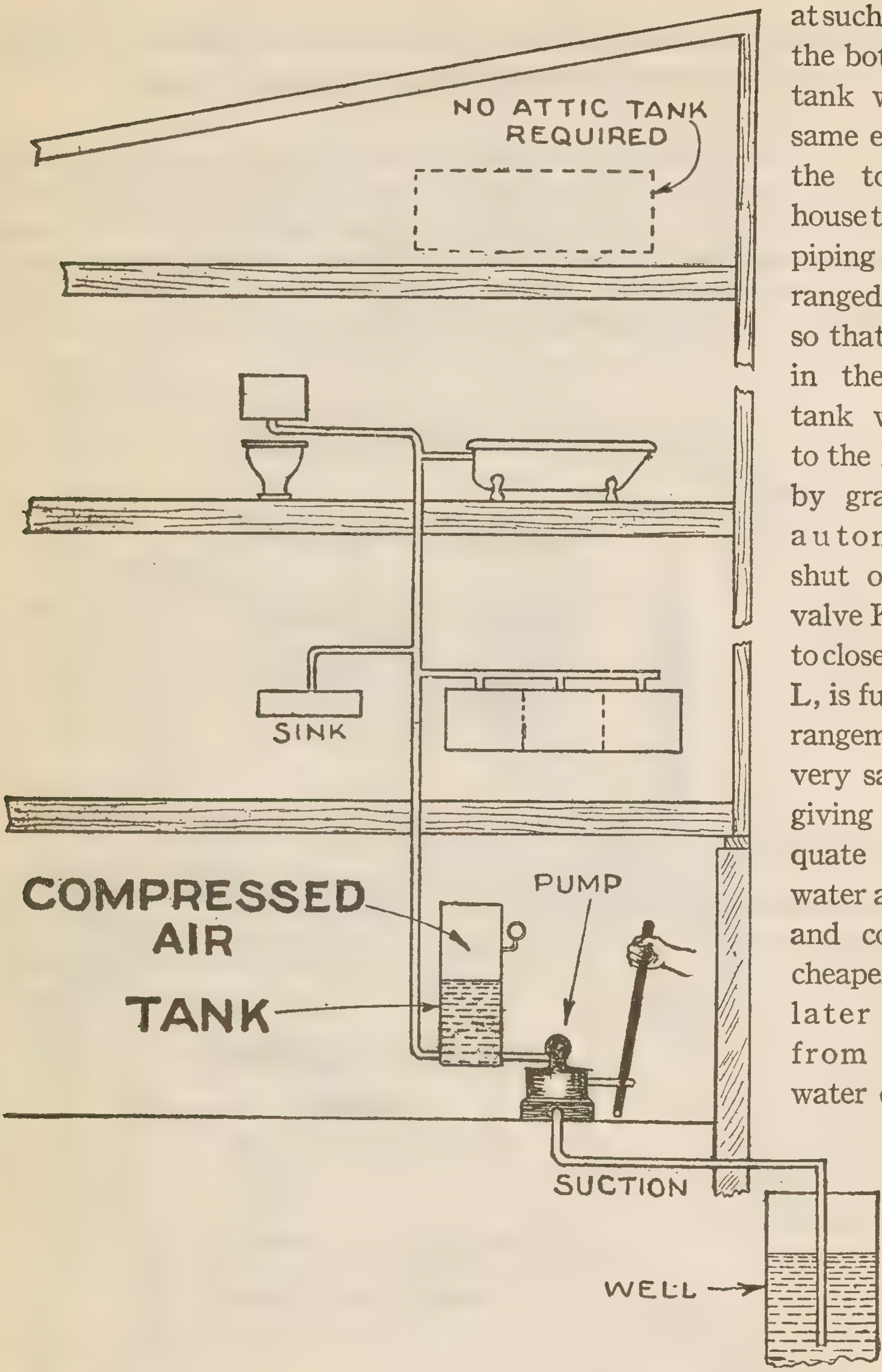


FIG. 6,557.—Enlarged view of tank shown in fig. 6,555, illustrates the various pipes connected with the tank.



at such height that the bottom of the tank was at the same elevation as the top of the house tank L. The piping was arranged as shown, so that the water in the wind mill tank would flow to the house tank by gravity until automatically shut off by float valve K, adjusted to close when tank L, is full. This arrangement proved very satisfactory, giving an adequate supply of water at all times, and considerably cheaper than was later obtained from the city water company.

FIG. 6,558.—Cold water supply piping 3, where water is taken from pressure tank; ***pneumatic system.***

Pneumatic System.—The word *pneumatic* is defined as *pertaining to devices that make use of compressed air.* Accordingly the pneumatic system of water supply makes use of compressed air to elevate the water to the various outlets in a building.

The apparatus required consists essentially of a closed cylindrical steel tank, a pump for raising the water from the

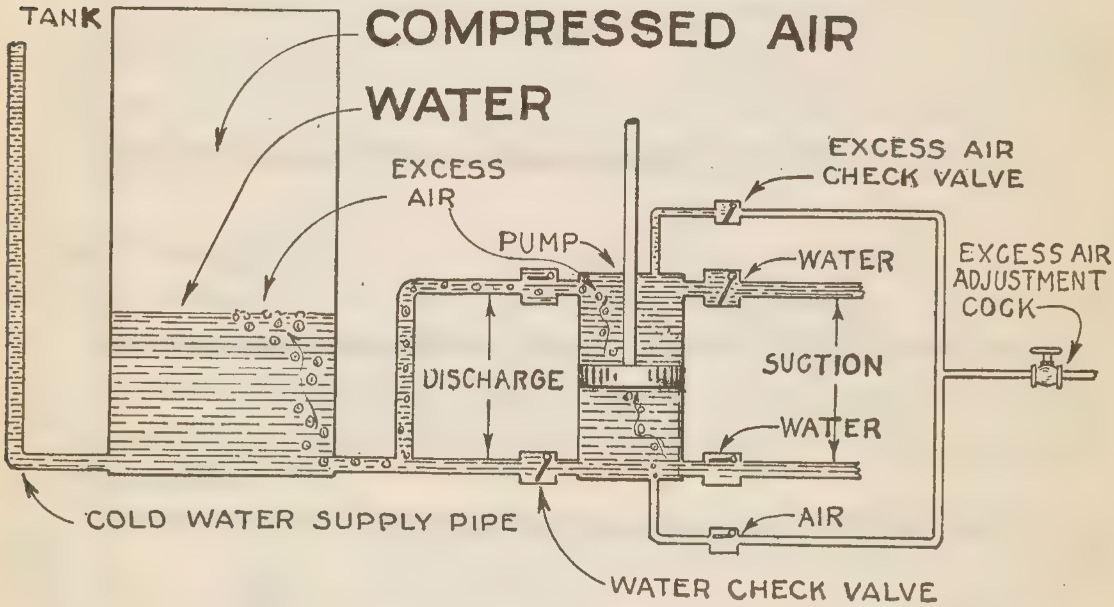
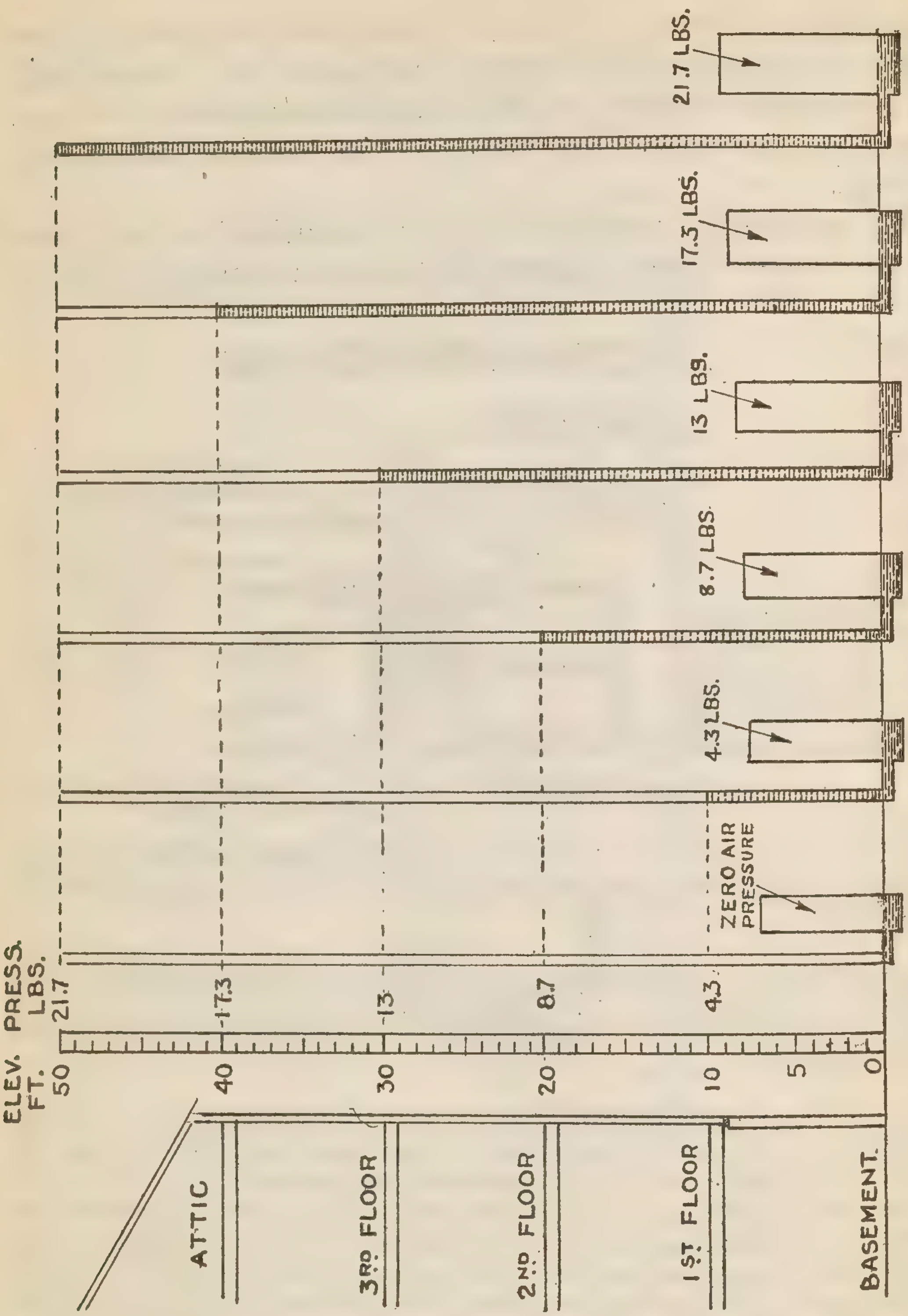


FIG. 6,559.—Enlarged view of pneumatic system shown in fig. 6,558, illustrating working of the apparatus.

source of supply, and forcing it into the tank. When there is no water in the tank, it contains air at atmospheric pressure or 14.7 lbs. per sq. in.

In operation, the pumping of water into the bottom of the tank will compress the air after opening into the tank has been closed and, as the air is lighter than water, it is compressed into the space above the water. As the water level rises at each stroke of the pump, the air becomes compressed more and more in the top of the tank, and finally reaches a desired point of compression where it is exerting upon the water in the tank a very strong pressure which pushes the water out from the tank and through the pipes to any part of the house or grounds, where it is then



FIGS. 6,560 to 6,566.—Air pressure in pneumatic systems necessary to force water up to the several floors in a building; diagram of static heads and corresponding pressures.

ready to flow from the faucet. Air is very elastic and acts much like a wound up spring. Its force becomes less when the air space expands and the volume of water decreases. By increasing or decreasing the amount of air put into the tank and also the pressure, pneumatic systems will meet the requirements of various locations requiring either a high or low pressure.

There should be provided an air charging device so that additional air may be pumped into the tank at each stroke of the pump if desired.

This device usually consists of a cock and a check valve attached to the cylinder head, as shown in fig. 6,559. A small quantity of air is forced into the pneumatic tank at each stroke of the pump, to maintain the tank pressure. The amount of air pumped may be controlled by adjusting the cock. Normally and for ordinary elevations little or no air is required.

Hot Water Supply.—If the principles upon which the successful operation of the hot water installations depend be first thoroughly understood, the mystery of how to properly arrange the piping would be cleared up, and there would be no complaint about this part of the plumbing. These important principles are:

1. *To heat water, there must be a circulation or movement of the water.*

2. *The natural circulation of water depends upon a difference in density caused by a difference in temperature.*

3. *Water contains mechanically mixed with it,* $^1/_{20}$ or 5% *of its volume of air, when under atmospheric pressure; this air readily separates from the water when vaporization and condensation takes place.*

4. *Air released from the water seeks the highest point in the system, unless "trapped" in a "pocket".*

Taking up these principles in the order given, fig. 6,567 is a familiar experiment which anyone can make, showing that without circulation throughout, water may be heated at one point and remain cold at another.

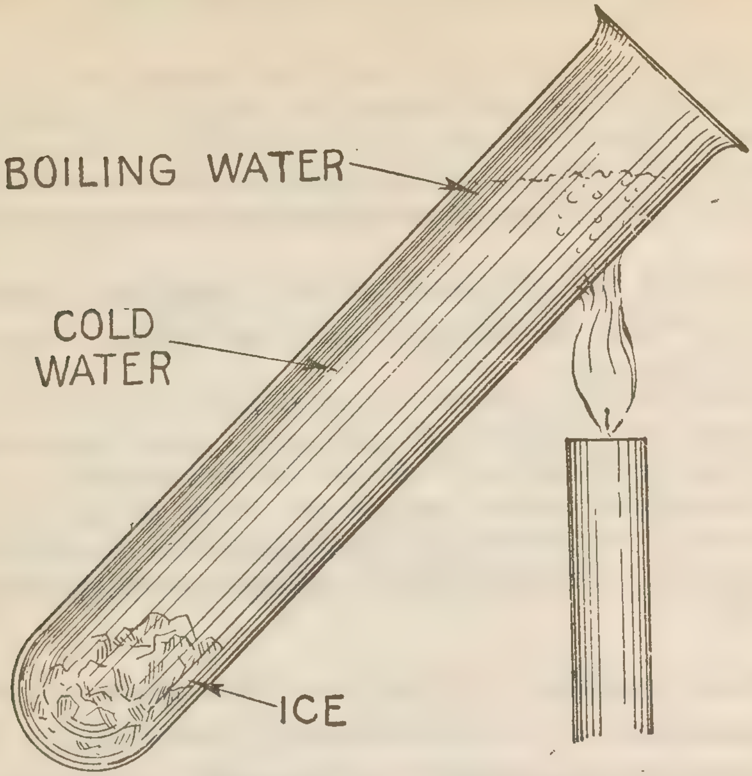


Fig. 6,567.—Experiment illustrating that water cannot be appreciably heated without circulation. A test tube filled with cold water having a piece of ice placed in the lower end, is heated at the top as shown. The water will soon boil at its upper surface while the temperature of the bottom of the tube is not perceptably changed.

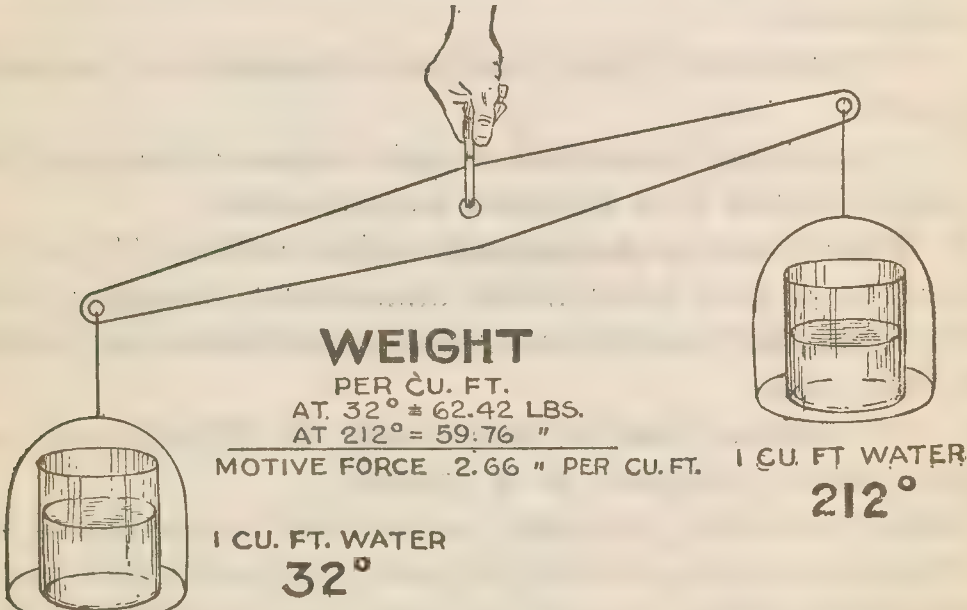
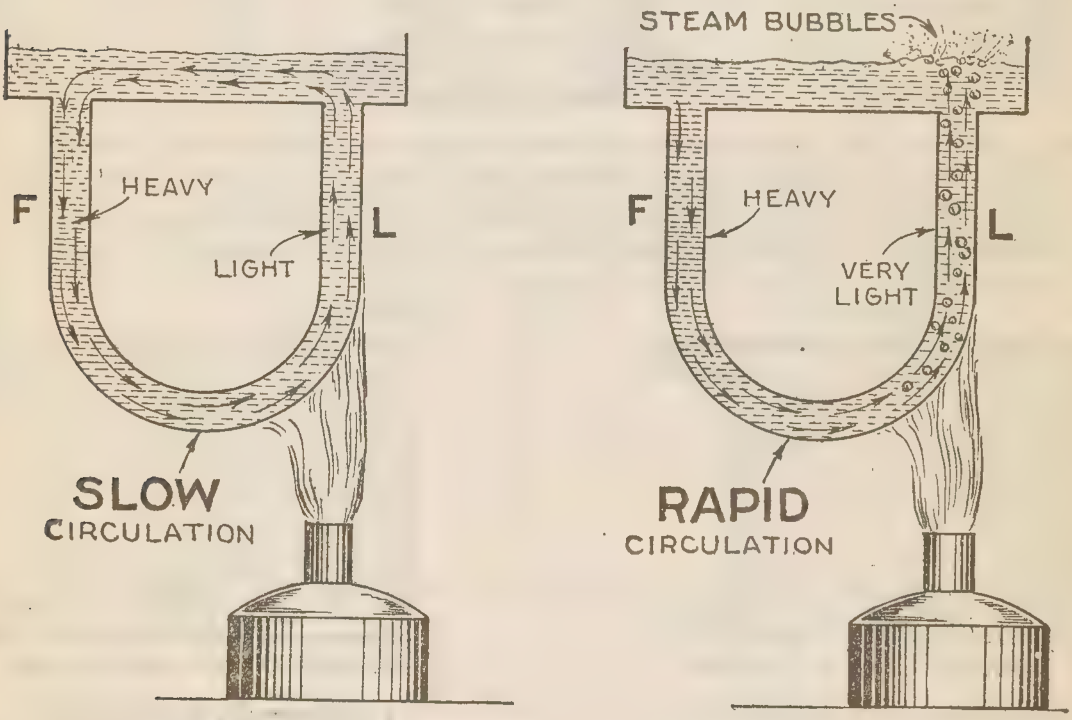


Fig. 6,568.—One cu. ft. of water at different temperatures illustrating that with rise of temperature the weight of water becomes less per unit volume.

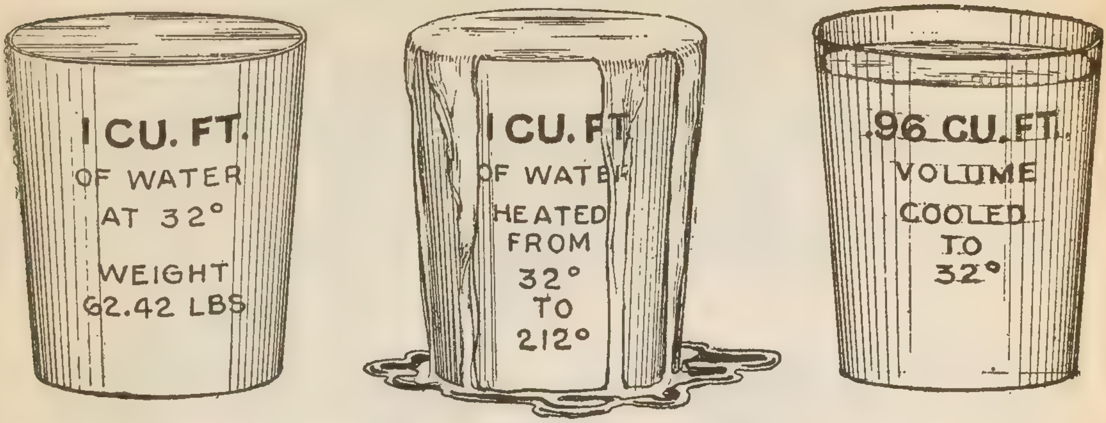
This is because water is a bad conductor of heat and receives heat principally by *convection*, or movement of the water. This movement of the water called "circulation," is due to the fact that when the temperature of part of the water in a heating system is raised above that in some other part, it expands, and becomes lighter per unit volume as shown in fig. 6,568. Thus equilibrium is disturbed, the cold and heavier water sinking toward the lowest point of the system, at the same time displacing or pushing up the hot portion of the water to the top of the system; in this way circulation



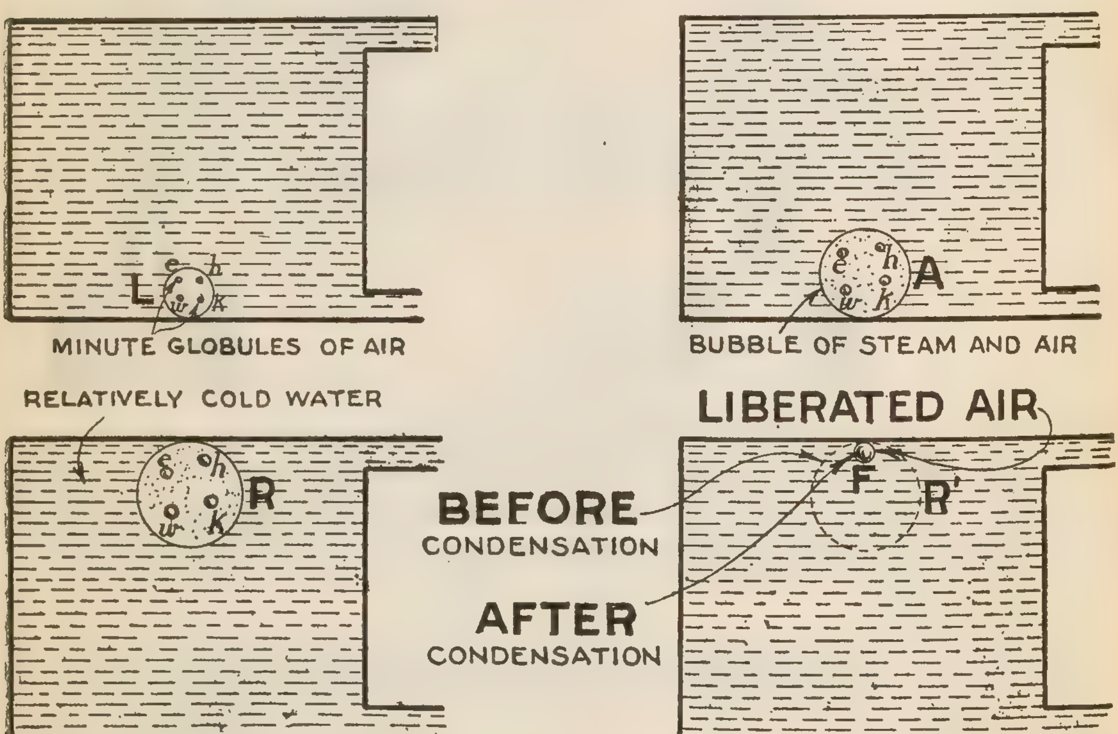
FIGS. 6,569 and 6,570.—Principle of circulation. ***As heat is applied*** to the "up flow" or "riser" L (fig. 6,569), the water in it expands, and becoming less dense is displaced by the colder and heavier water in the "down flow" F, thus causing the water to circulate as indicated by the arrows. The small difference in density thus caused produces a slow circulation of the water. As the heating is continued and steam is formed, the column of water in the riser L (fig. 6,570), becomes much lighter than the column in the down flow tube F, producing a rapid circulation.

is established as in figs. 6,569 and 6,570. The experiment illustrated in figs. 6,571 to 6,573 will show why hot water is lighter than cold water.

The uninformed no doubt often wonder why a lot of air comes out with the water from a hot water faucet when the latter has not been opened for some time, and yet they do



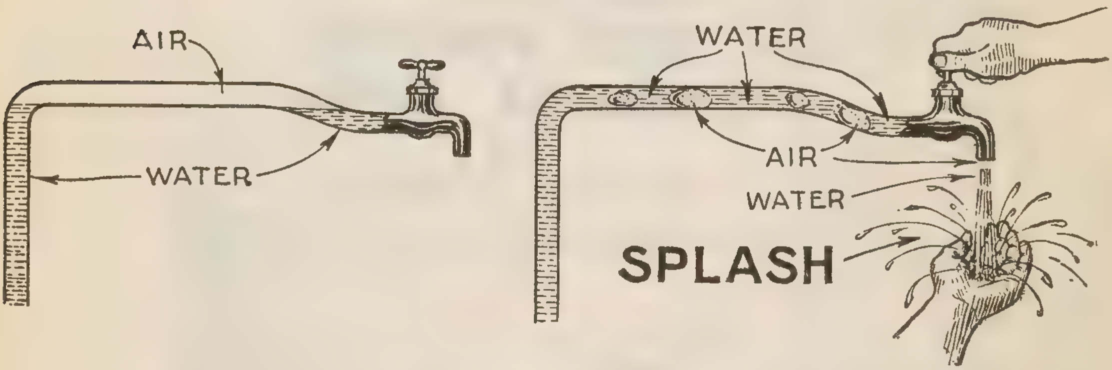
FIGS. 6,571 to 6,573.—Experiment illustrating why hot water is lighter than cold water. A vessel of 1 cu. ft. capacity is filled with water at 32° Fahr. If the water be heated to 212° it will expand and 2.62 lbs. of the water will spill over the sides of the vessel. Now if the heated water remaining in the vessel be cooled to 32°, its volume will shrink to .96 cu. ft., which obviously must weigh less than the full cu. ft. of water (in fig. 6,571), at the same temperature.



FIGS. 6,574 to 6,577.—Liberation of air mechanically mixed with water. The figures show an elementary water back for heating water such as is fitted to kitchen stoves. Assuming the water back to be full of water as in fig. 6,574 let **L**, represent a unit volume of the water the size of a pinhead but here magnified. This unit volume or drop of water will contain a number of minute globules of air as *e,h,k,w*, mechanically mixed with it, that is held in suspension.

not take the trouble to find out the reason for the common and often disagreeable occurrence.

As stated in principle 3, air contains water mechanically mixed with the globules of air thus mixed are so minute that they are not visible to the eye. This air is separated from the water by the process of alternate evaporation and condensation which is continually taking place in every heating apparatus as shown in figs. 6,574 to 6,577. Evidently, when hot water is not drawn off in some time, a considerable amount of air will be liberated from the water, which will rise in the pipes and lodge in any pocket as in fig. 6,578, so that when water is drawn, the disagreeable result shown in fig. 6,579 follows.



FIGS. 6,578 and 6,579.—Accumulation of liberated air at high point and result when hot water faucet is opened.

When the foregoing principles are thoroughly understood, the proper piping of a hot water system should present no difficulty.

FIGS. 6,574 to 6,577—*Text Continued.*

Now as heat is supplied, this unit mixture of water and air **L**, the water will be changed to steam, giving a bubble compound of a mixture of steam and air as **A**, in fig. 6,575. The bubble being lighter than an equal volume of water, will become disengaged from the hot surface of the metal and will rise to the top as at **R**, fig. 6,576. The water at the top being relatively cold, will cause condensation of the steam in bubble **R**, ***liberating the air*** as at F, fig. 6,577. Here note relative size of steam bubble indicated by **R′**, and liberated air bubble F. Evidently when this process continually takes place on a large scale as in a hot water system considerable air will be liberated and hence the importance of proper arrangement of the system to avoid "pockets" for the lodgment of this air, especially in the water back or heating part of the system.

Any hot water system is made up essentially of these elements:

1. Heater.

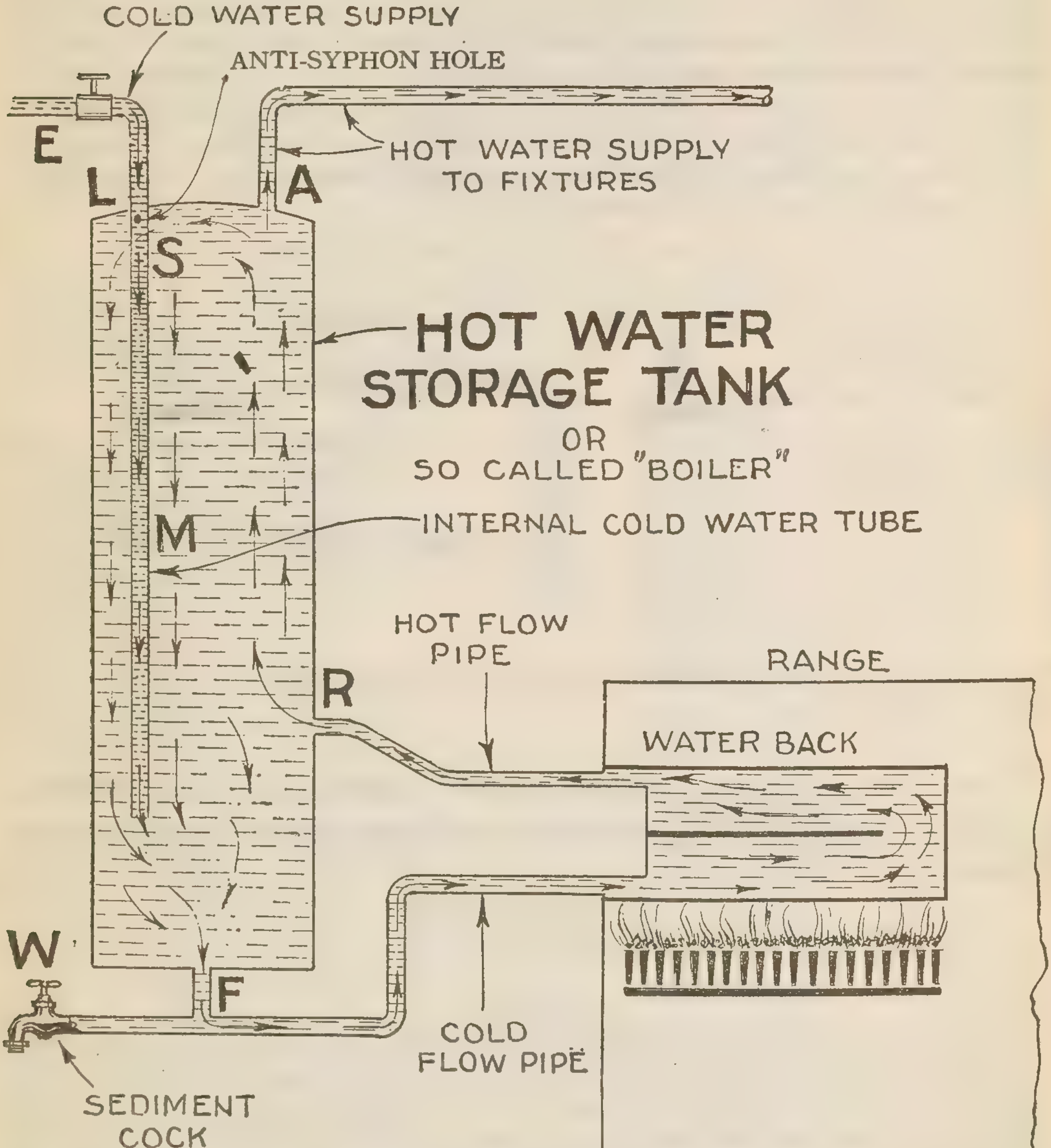


FIG. 6,580.—Elementary domestic hot water system illustrating the essential features and operation. L, cold water inlet; A, hot water outlet; R, hot flow inlet; F, cold flow outlet; M, internal cold water tube; S, anti-syphon hole; E, cold water shut off valve; W, sediment cock.

2. Storage tank.
3. Piping.

Water Back.—For domestic supply the heater known as a water back consists of a box-like casting which fits in the

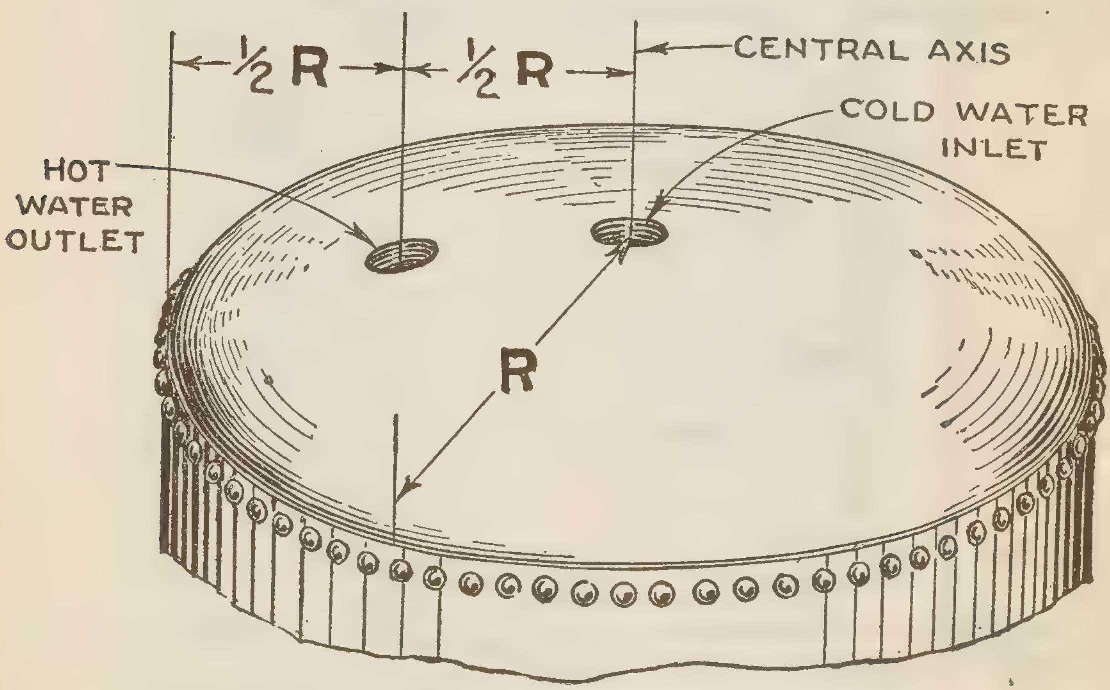


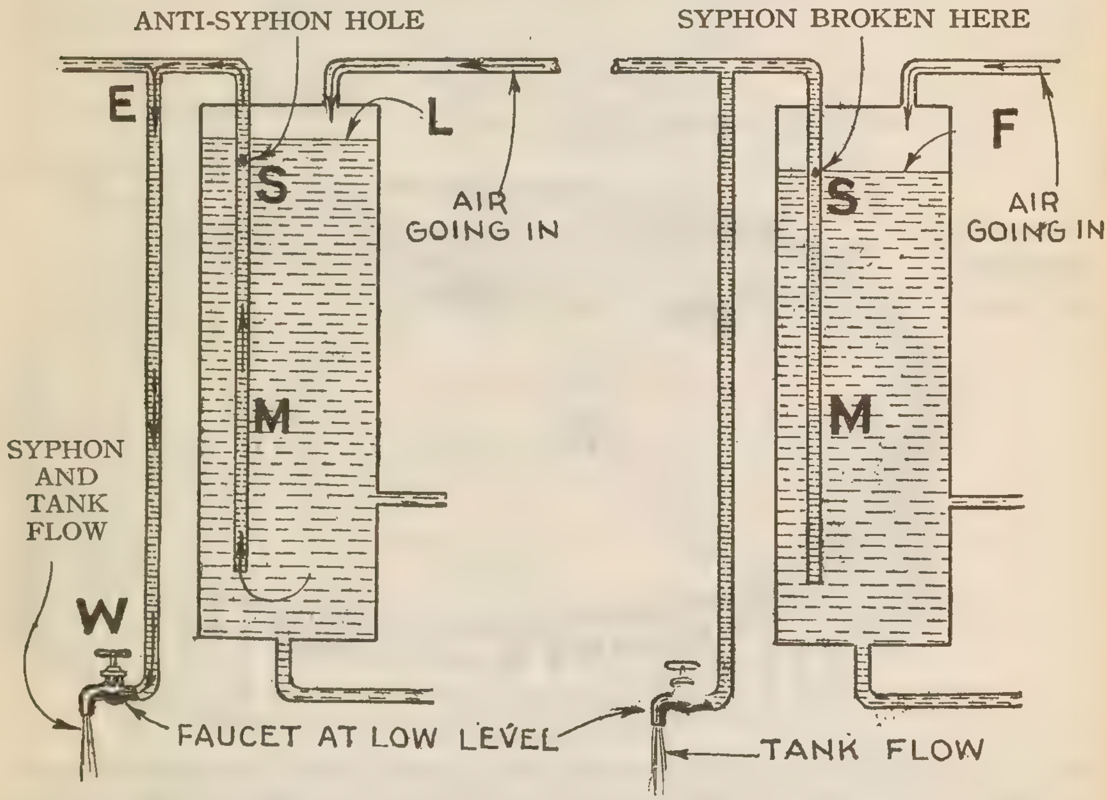
Fig. 6,581.—Usual location of top holes in hot water tanks. ***This arrangement*** bringing as it does the cold water inlet discharge nearer the hot side of the tank is less efficient thermally though it perhaps brings less strain on the shell due to less inequality of temperatures.

kitchen range or stove and has an inlet, interior baffle, and outlet, as shown in fig. 6,580.

Hot Water Storage Tank.—The hot water storage tank, which is ignorantly and persistently called "range boiler," or just "boiler" is also shown in the illustration together with

the piping connections. In fig. 6,580 the storage tank has four openings: two on top, one on the side and one on the bottom.*

Cold water supply connection is made at L, and hot water drawn at A: the heater or water back is connected at R and F. The cold water supply is led to a point near the bottom of the tank by an internal tube M, having



FIGS. 6,582 and 6,583.—Operation of anti-syphon hole to prevent syphonage of water out of storage tank when one or more low level faucets are opened wide. In the figures M, is the internal tube and S, the anti-syphon hole in same. The opening of a low level faucet as W, will cause a tremendous suction at the point E, where pipe from attic tank branches to storage tank and faucet W. This considerable reduction of pressure in the pipe at junction E, will not only increase the flow from house tank but will "suck" or siphon the water out of storage tank through internal tube M, until the receding water level L (fig. 6,582), reaches the elevation F, of the anti-syphon hole S, as shown in fig. 6,583, when air which comes in through the hot water inlet will enter hole S, and break the syphon thus stopping the flow of water from the storage tank.

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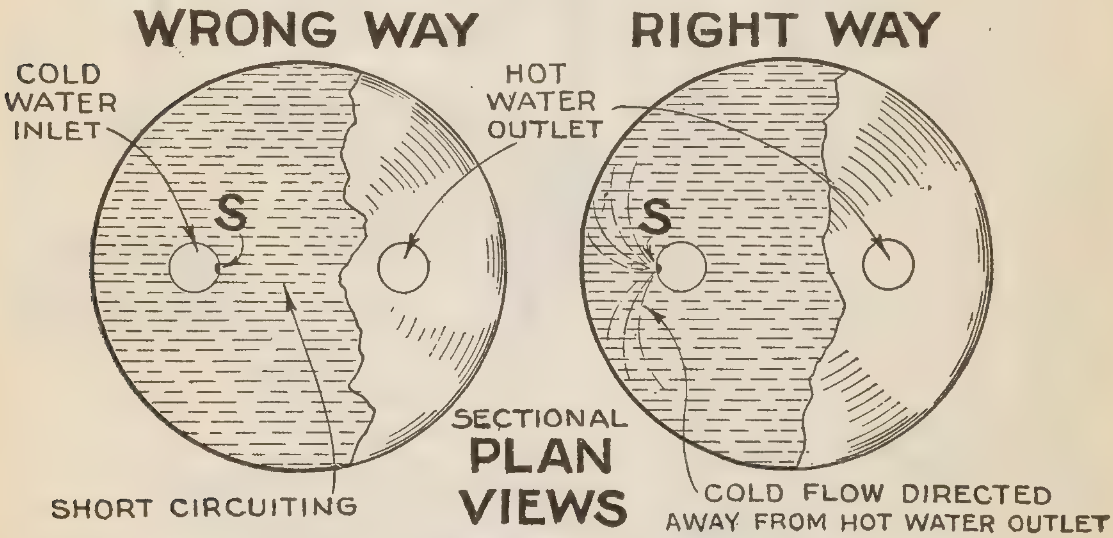
*NOTE.—***For maximum efficiency** the two top openings should be located near the sides, diametrically opposite as shown in fig. 6,580, rather than the usual commercial location shown in fig. 6,581.

an anti-syphon hole S, (incorrectly called syphon hole) tapped near the top. A shut off valve E, is provided to permit repairs. Sediment is removed through the sediment cock W.

In operation, assuming the system to be full of water, and that heat is supplied to the water back, the water therein as its temperature rises, will expand and become lighter than the cold water in the tank. This will cause a circulation to take place as indicated by the arrows, the hot water rising to the top of the tank, and the cold water flowing down to the bottom and back to the water back via the cold water pipe. This circulation cycle is continually repeated as long as the water in the water back is raised to a temperature higher than that in other parts of the system.



FIGS. 6,584 and 6,585.—Sectional plan views of storage tank showing ***wrong way*** and ***right way*** location of anti-syphon hole in internal cold water supply tube. If the hole S, point toward the hot water outlet as in fig. 6,584, cold water issuing from the hole will mix with the hot water lowering its temperature; if pointed in opposite direction as in fig. 6,585, the cooling effect will obviously be a minimum.

When hot water is drawn off from A, an equal amount of cold water comes in at E, and is led to the lower part of the tank by the internal tube M, otherwise there would be a tendency for the cold water to short circuit from L to A, cooling off the supply.

An important provision for storage tanks is an *anti-syphon hole* (erroneously called *syphon* hole) located on the internal tube of the cold water supply pipe. The operation of this

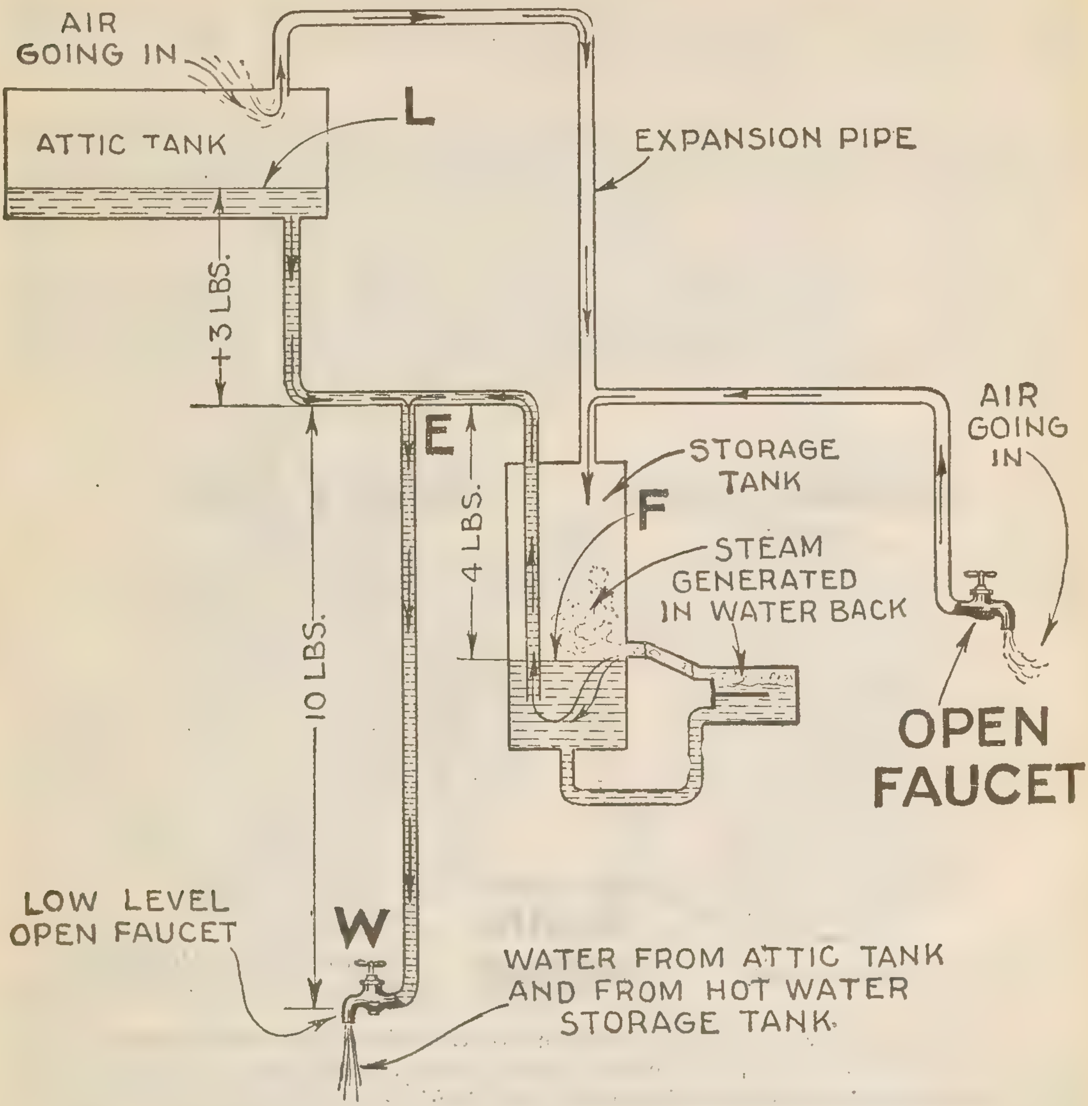


FIG. 6,586.—Abnormal conditions in hot water system showing how water is syphoned out of storage tank in absence of anti-siphon hole. ***Assume*** that the relative elevations of attic tank, storage tank and low level faucet are such that *referred to elevation of junction* E, there is a (+) 3 lb. head to water level L, in attic tank; a (−) 4 lb. suction to water level F, in storage tank, and a (−) 10 lb. suction to low level faucet W. The suction caused by opening faucet W, will cause a considerable reduction of pressure at junction E. Thus at the instant depicted, water enters junction E, from attic tank at 3 lbs. above atmospheric pressure and considering the 10 lb. suction due to low level faucet W, the total pressure causing water to flow from attic tank is 3+10=13 lbs. Since the storage tank is open to the atmosphere through expansion pipe or open faucet, the pressure at elevation F, which causes water to syphon out of the storage tank is that due to the two columns of water elevations EF and EW, which in this case is 10−4=6 lbs. Disregarding frictional resistance the relative amounts of water flowing from attic tank and syphoned from storage tank are as 13:6 that is the flow from attic tank is a little over 2 times that from storage tank.

hole in stopping the syphoning of water from the storage tank under abnormal conditions in the system is shown in figs. 6,582 and 6,583 and the undesirable results which might obtain in its absence, in fig. 6,586.

The position of this hole is important, since when cold water is being supplied to the tank it not only enters through the lower end of the supply tube but also in small amount through the anti-syphon hole S. Evidently, then, the hole S should look in a direction away from the hot water outlet to reduce short circuiting to a minimum; figs. 6,584 and 6,585 explain this.

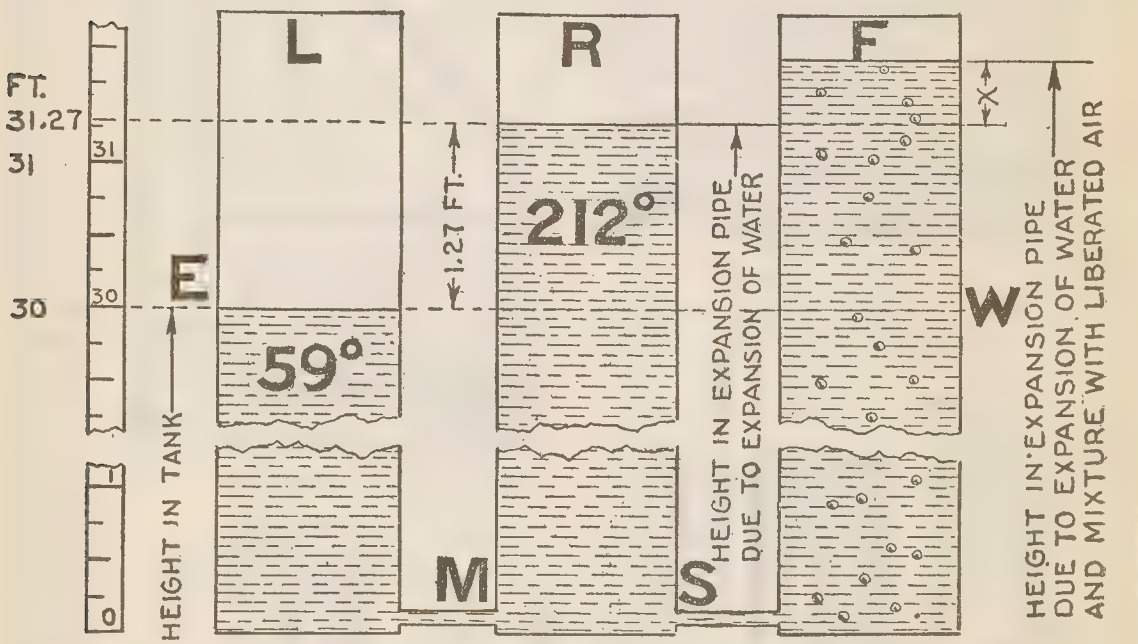
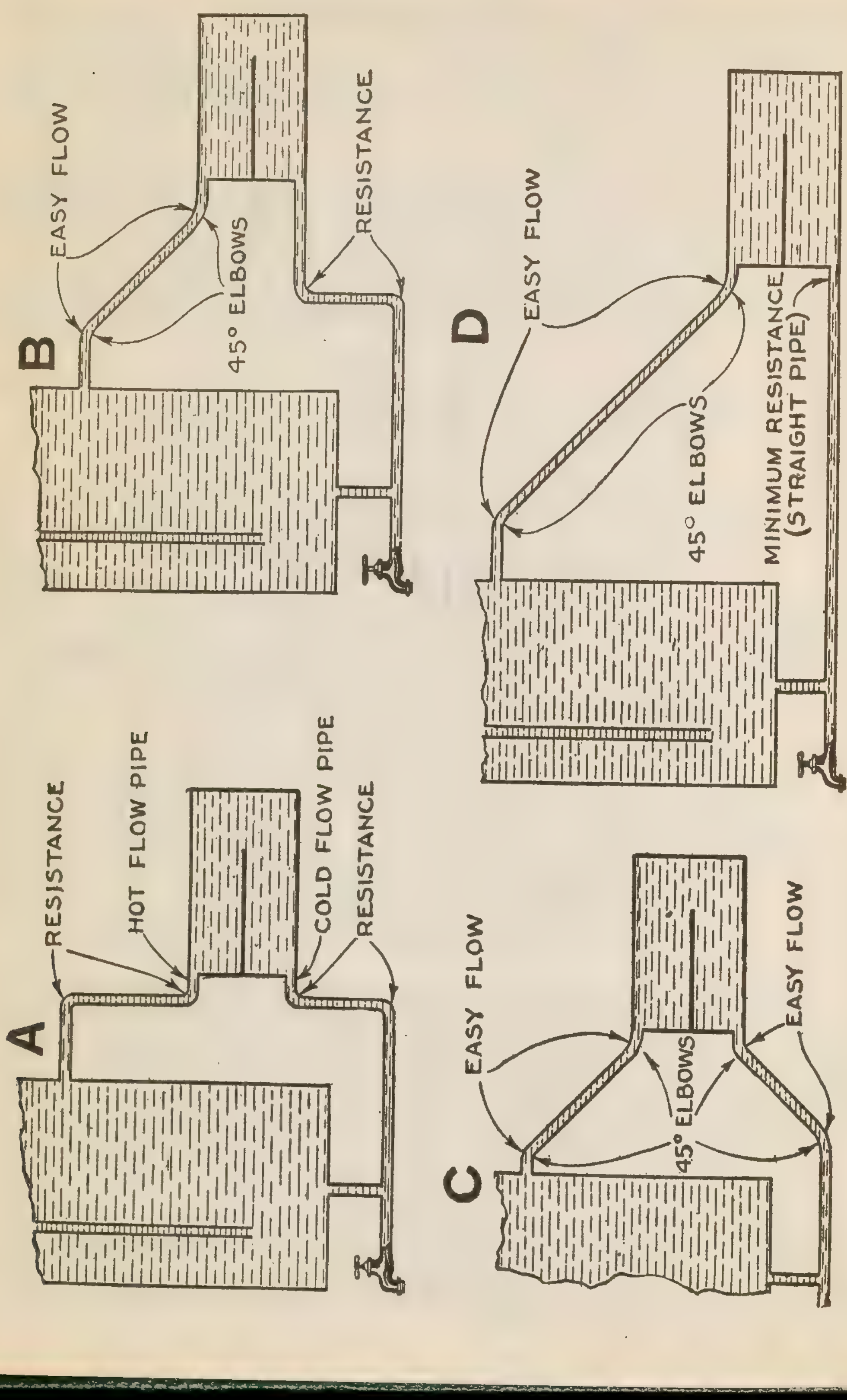


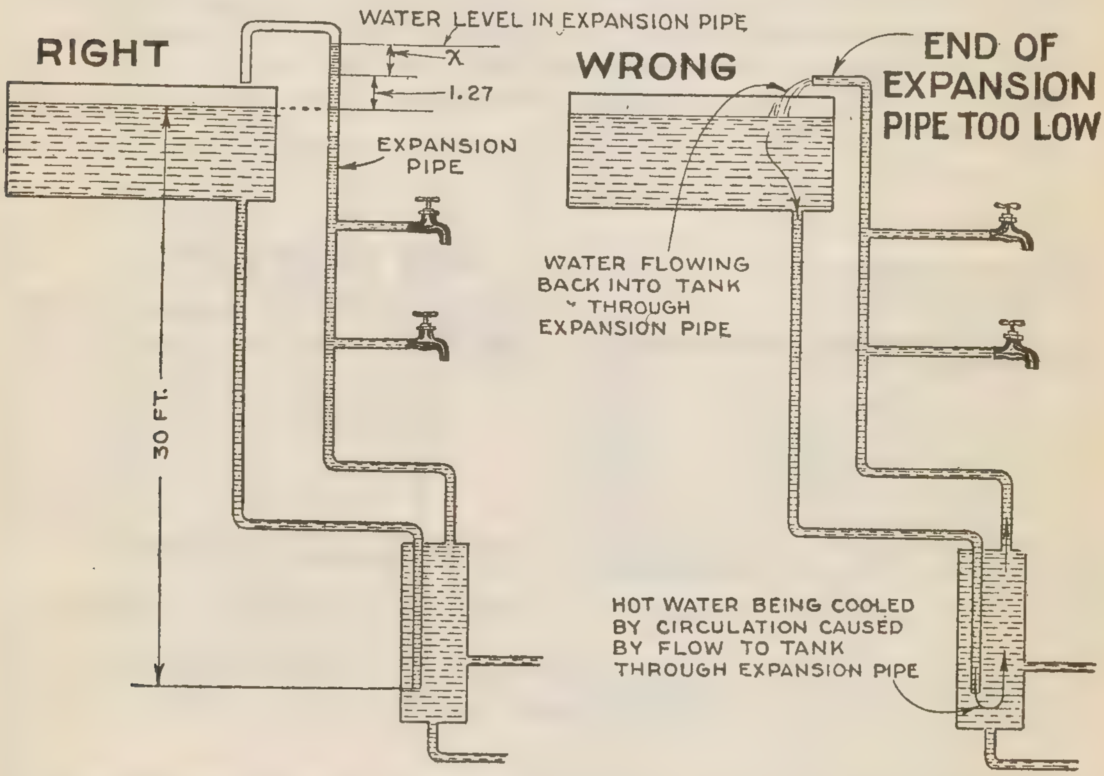
FIG. 6,587.—Diagrams illustrating why the expansion pipe should extend above water level in attic tank. Let L, R, F, represent three vertical pipes connected by the tubes M, S. If water be poured into the pipes and the temperature be the same in each, the water will rise to the same level in each since they are connected by tubes MS. Suppose they be filled with water at 59° to a level of 30 ft. from the bottom as represented by EW, and that the water in R be heated to 212°. If volume of water at 39.1° Fahr. (maximum density) be represented then (according to Kopp and Porter) volume at 59° = 1.00083, and at 212° = 1.04332. Increase in volume = 1.04332 − 1.00083 = .04249. That is the head is increased .04249 ft. for each foot head. Hence, if column of cold water in pipe L, be 30 ft. high, column of hot water in pipe R, due to its expansion alone will be 30× (1 + .04249) = 31.27 ft. high as shown on the scale. Now considering the air being liberated and passing up through the water in expansion pipe as indicated in pipe F, the density of the water will be still further reduced and the water will rise an additional distance indicated by X, depending upon the amount of air passing up through the water. Hence the necessity of carrying the expansion pipe up higher than the water level in tank.



FIGS. 6,588 to 6,591.—Various methods of connecting water back to storage tank. **A**, maximum resistance to circulation of water; **B**, resistance reduced in hot flow pipe by use of 45° elbows; **C**, resistance reduced in both hot and cold flow pipes by use of elbows; **D**, minimum resistance to flow by use of 45° elbows in hot flow pipe and straight cold pipe (storage tank raised to permit this.)

Another important item is the proper piping of the expansion pipe.

Owing to the expansion of the water on heating and the liberated air passing through it in the expansion pipe, the water level therein will be higher than in the attic tank as shown in fig. 6,587. Accordingly the expansion pipe must be carried up beyond the water level in the tank sufficiently to allow for this, otherwise there would be a back flow through expansion pipe into the tank, causing a circulation which would cool the



FIGS. 6,592 and 6,593.—***Right*** and ***wrong*** installation of expansion pipe. Fig. 6,592 shows expansion pipe carried up above static level of the heated water as it should be to prevent back flow into attic tank; the figure shows proper installation for the conditions shown in fig. 6,587. Fig. 6,593 shows same installation with expansion pipe not carried up high enough. Evidently when outlet of expansion pipe is below static level of the hot water, there will be a continued flow back to attic tank which will have the wasteful effect of cooling the hot water in storage tank.

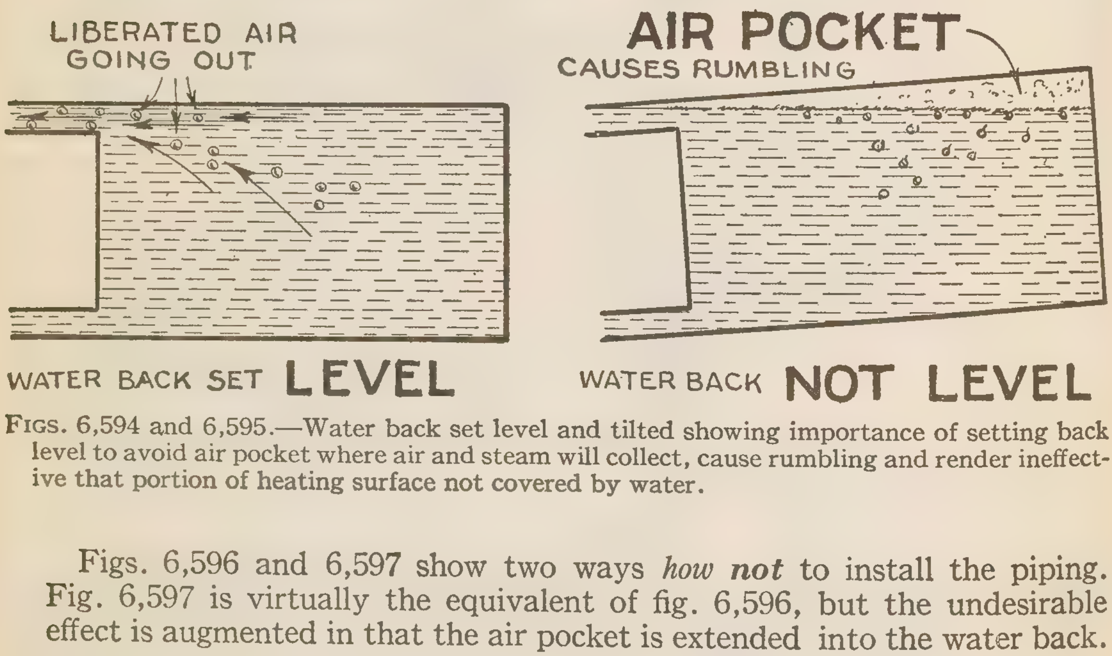
hot water in storage tank as shown in fig. 6,593. The proper piping of expansion pipe is shown in fig. 6,592.

In setting the water back care should be taken to have it

level to avoid water pockets and resulting impaired action, as shown in figs. 6,594 and 6,595.

The method of connecting water back to storage tank should be such that there will be the least resistance to the flow of water and give no chance for the formation of air pockets.

Fig. 6,588 shows a common and objectionable method which employs four 90° elbows giving maximum resistance to flow. Conditions are progressively for flow as shown in figs. 6,589 to 6,591, the latter being employed where there is sufficient head room to bring lower connections on level with intake to water back, and space enough for the 45° run. Air pockets in the piping between water back and storage tank are objectionable.

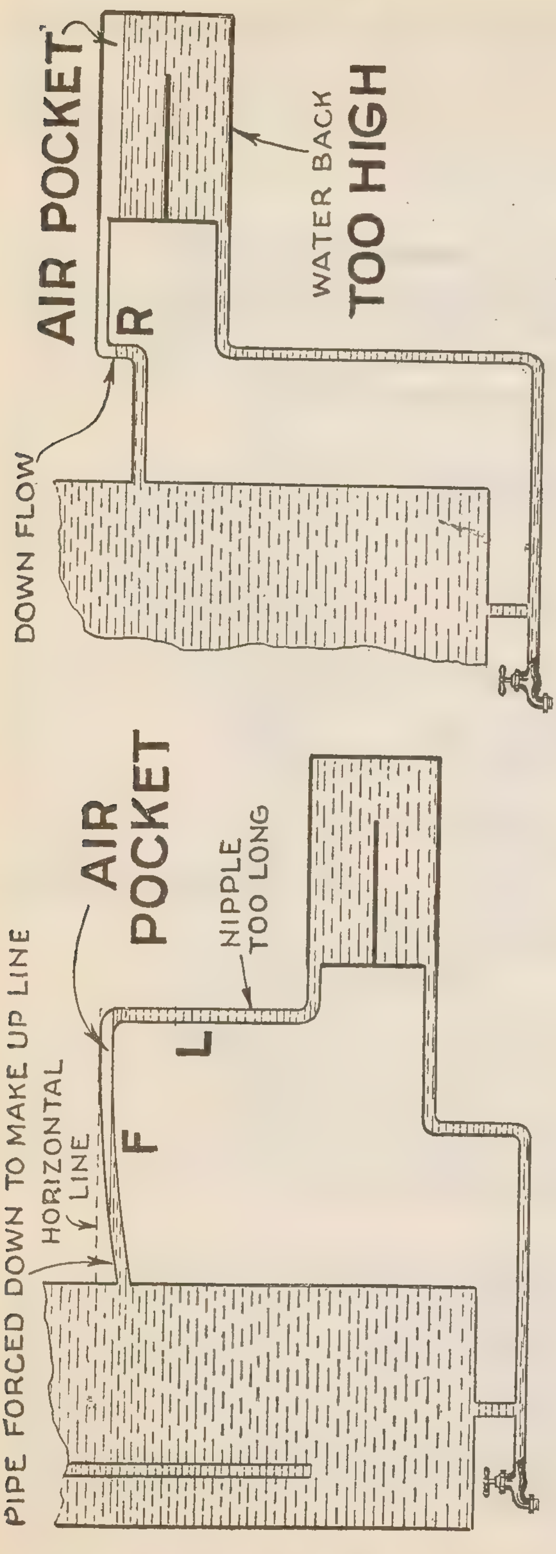


FIGS. 6,594 and 6,595.—Water back set level and tilted showing importance of setting back level to avoid air pocket where air and steam will collect, cause rumbling and render ineffective that portion of heating surface not covered by water.

Figs. 6,596 and 6,597 show two ways *how **not*** to install the piping. Fig. 6,597 is virtually the equivalent of fig. 6,596, but the undesirable effect is augmented in that the air pocket is extended into the water back.

Air Lock.—This troublesome condition is encountered in a good many hot water systems, because the plumber in laying out the piping didn't understand the principle involved.

By definition, air lock is *the accumulation in the piping of a quantity of air so located that a back pressure is produced therein*



FIGS. 6,596 and 6,597.—Air pocket due to improper piping between water back and storage tank. In fig. 6,596, the nipple L was cut *too long*, and the pipe fitter instead of taking time to recut L to correct length, forced down or even bent pipe F, to make up the line, thus producing a condition for air pocket as shown. The least that can be said is that it is a ***very bum** job of pipe fitting;* fig. 6,597, shows an even more objectionable installation the short nipple and elbows being introduced at R, because either the tank was set too low, or range with water back too high.

sufficient to balance the forward or supply pressure, which condition prevents flow of water from the outlets.

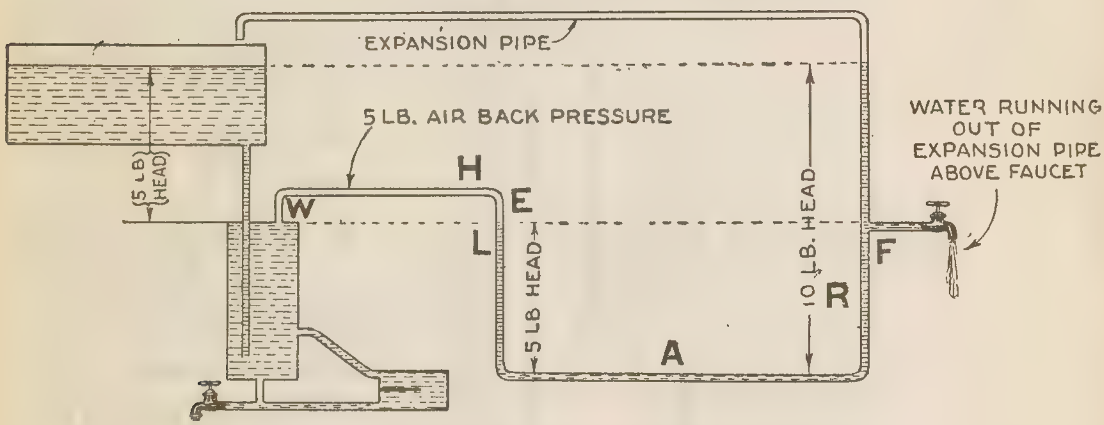
The importance of the subject is such that the author has attempted to make the explanation as simple as possible by aid of figs. 6,598 and 6,599. Air lock, as clearly seen from the diagram and explanation, is due to low supply pressure and wrong location of the expansion pipe. If the latter were arranged as in fig. 6,600, so that air would pass out of the system instead of accumulating, air lock would be impossible.

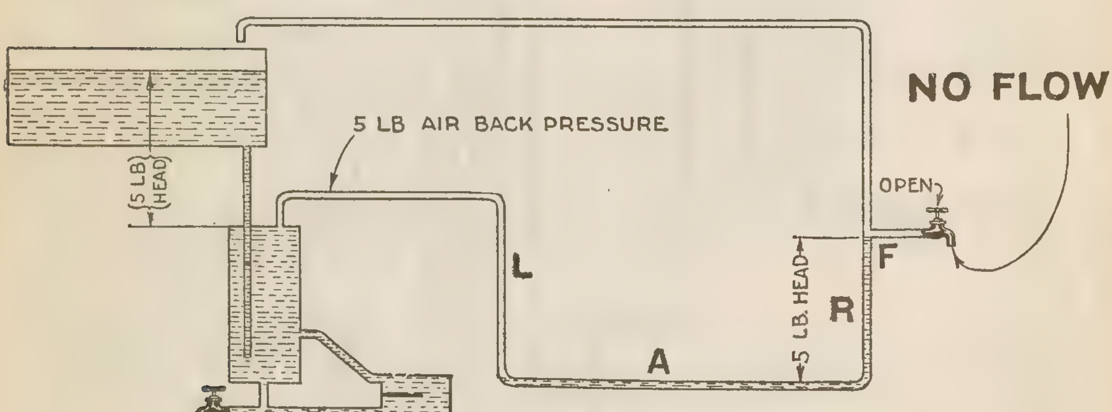
An ignorant or unscrupulous plumber will connect the expansion pipe as in

fig. 6,598, when a few feet of pipe may be saved, or the work done with less trouble.

Figs. 6,601 to 6,603 show why air lock is not encountered on systems having high pressure supply.

Quick Heating Storage Tank Connections.—The rate at which heat is transmitted from the fire to the water passing





FIGS. 6,598 and 6,599.—Faulty hot water system subject to ***air lock.*** Assume a low attic tank giving a head of water above storage tank equivalent to 5 lbs. pressure. The hot water pipe includes a loop L,A,R, with faucet F, at such elevation that when column of water in pipe R, stands at elevation of F, it will give a back pressure of 5 lbs. Now at the instant depicted, assuming a 5 lb. head of water in pipe L, 5 lbs. air pressure in loop E,H,W, and the faucet F to be opened. At this instant the water in expansion pipe above F will quickly run out, then the flow will be greatly decreased, the water trickling out of the faucet as more air accumulates in the water pocket, or until the column of water in L, is pushed down to the bottom of that pipe, when the back pressure due to the water in R, balances the air pressure and the flow through the faucet ceases.

through the water back depends upon *the difference of temperature between the fire and the water.*

That is, for constant temperature of the fire, the lower the temperature of the water, passing through the water back, the more rapid the absorption of heat.

Now in operation the water at the top of the tank is at the highest temperature and that at the bottom at the lowest. Hence the nearer the temperature of the water passing through the water back approaches that of the water at the bottom of the tank the more rapid will be the heating of the volume of water in the tank. The temperature of the water passing

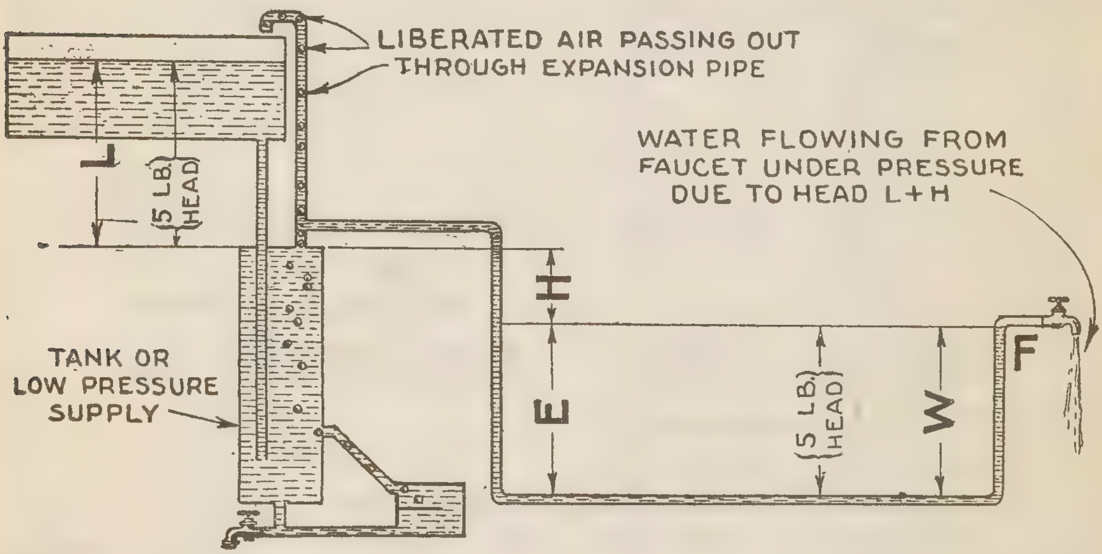
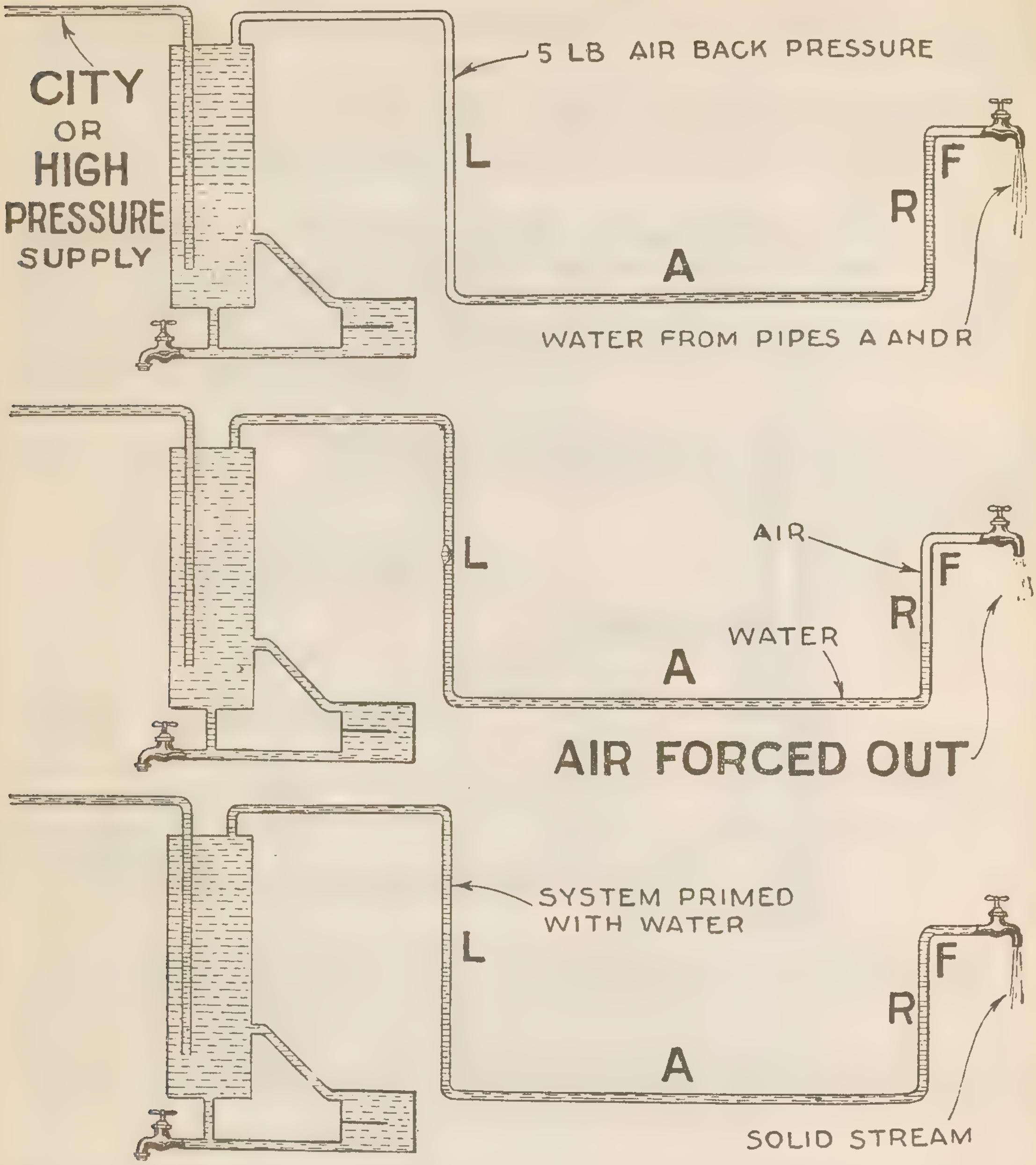


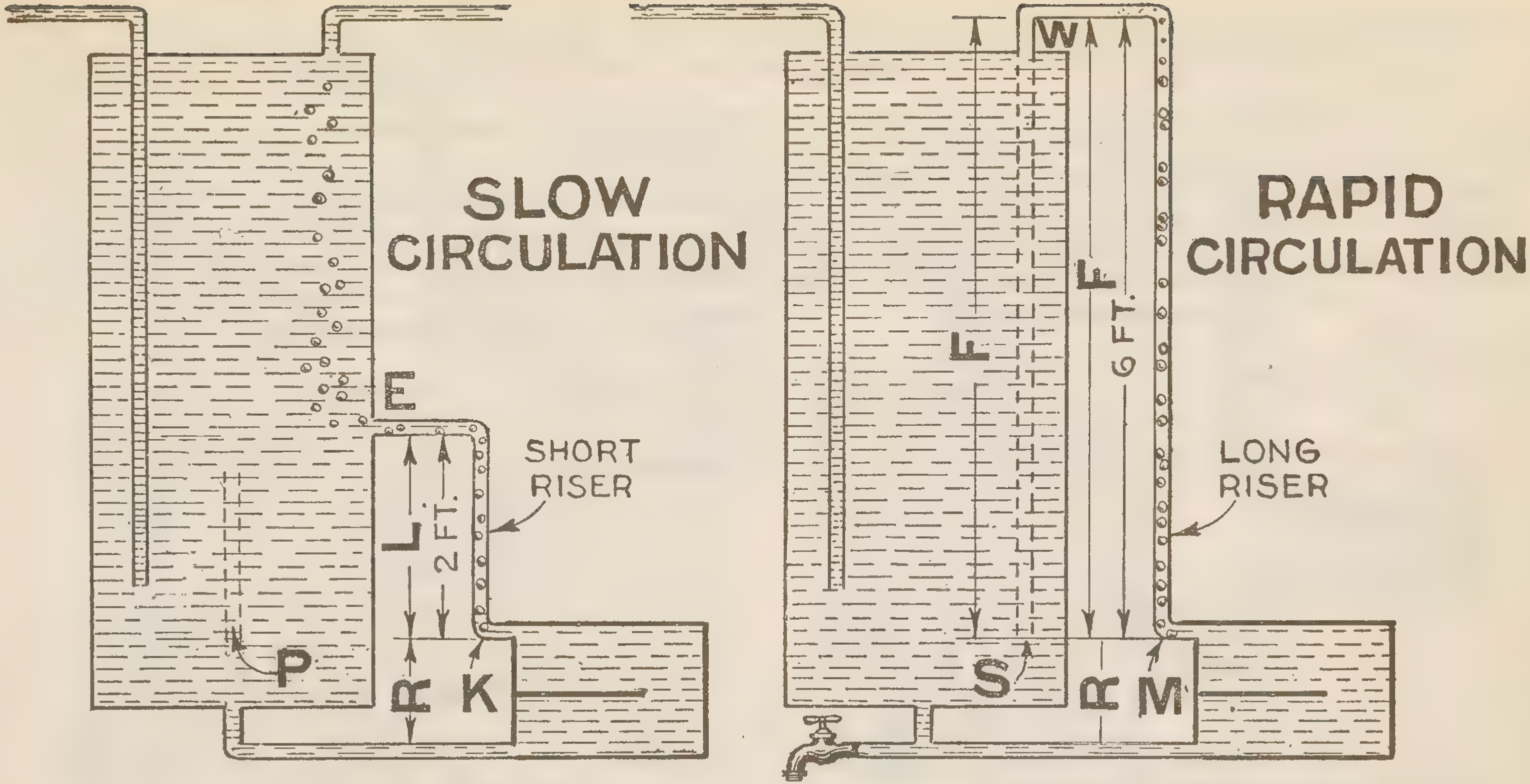
FIG. 6,600.—Correct location of expansion pipe to prevent accumulation of air and thus avoid air leak. By thus placing expansion pipe, the air as can be seen passes off as soon as liberated. The system being full of water, evidently when faucet F, is opened, water will issue there, from at a pressure due to head L+H, the 5 lb. head due to water in portion of piping E, being balanced by the back pressure due to 5 lb. head in portion of pipe W; clearly then the effective head is that due to difference in elevation of tank and faucet F, that is effective head =L+H.

through the water back depends upon its rate of flow or rapidity of circulation; the more rapid the circulation, the lower the temperature.

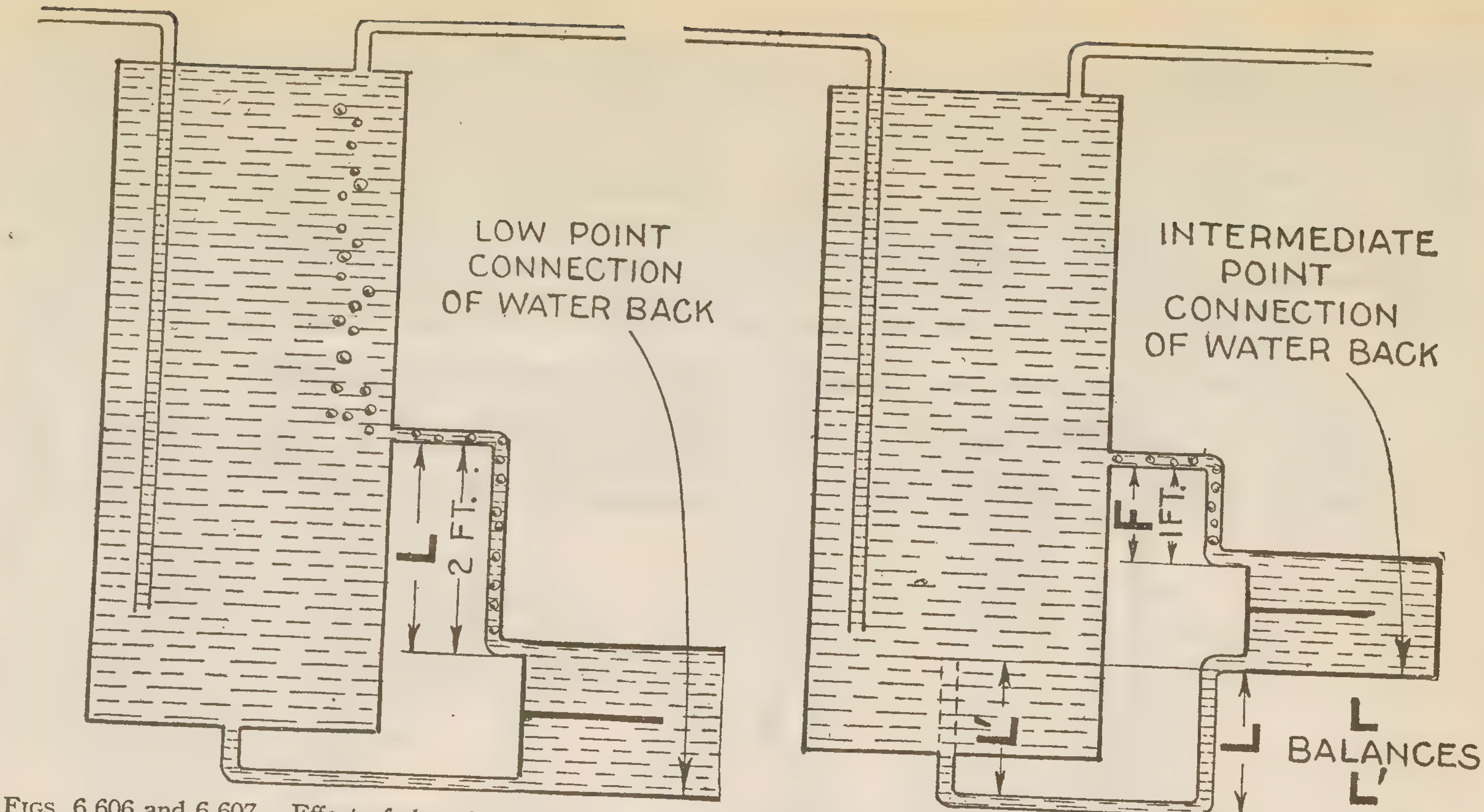
The rate of circulation depends upon the height of the ascending column of heated water, because hot water is lighter than cold water as already explained; *the longer the ascending column of hot water, the more rapid the circulation.* To make this perfectly clear, an extreme case is taken where half the water passing through the water back is converted into steam as illustrated in figs. 6,604 and 6,605.



FIGS. 6,601 to 6,603.—Operation of high pressure supply hot water system in preventing air lock. Since there is no expansion pipe, air will accumulate in the system. In fig. 6,601, assume portion of the piping L, to contain air and A,R, water. When faucet F, is opened, the city or high pressure supply which is in excess of the back pressure due to head of water in R, will force out water in pipes A and R, followed by air in L. Fig. 6,602, shows air passing out of faucet followed by solid column of water in L and A, and rising in R; fig. 6,603, shows system completely purged of air and solid stream of water issuing from faucet F.

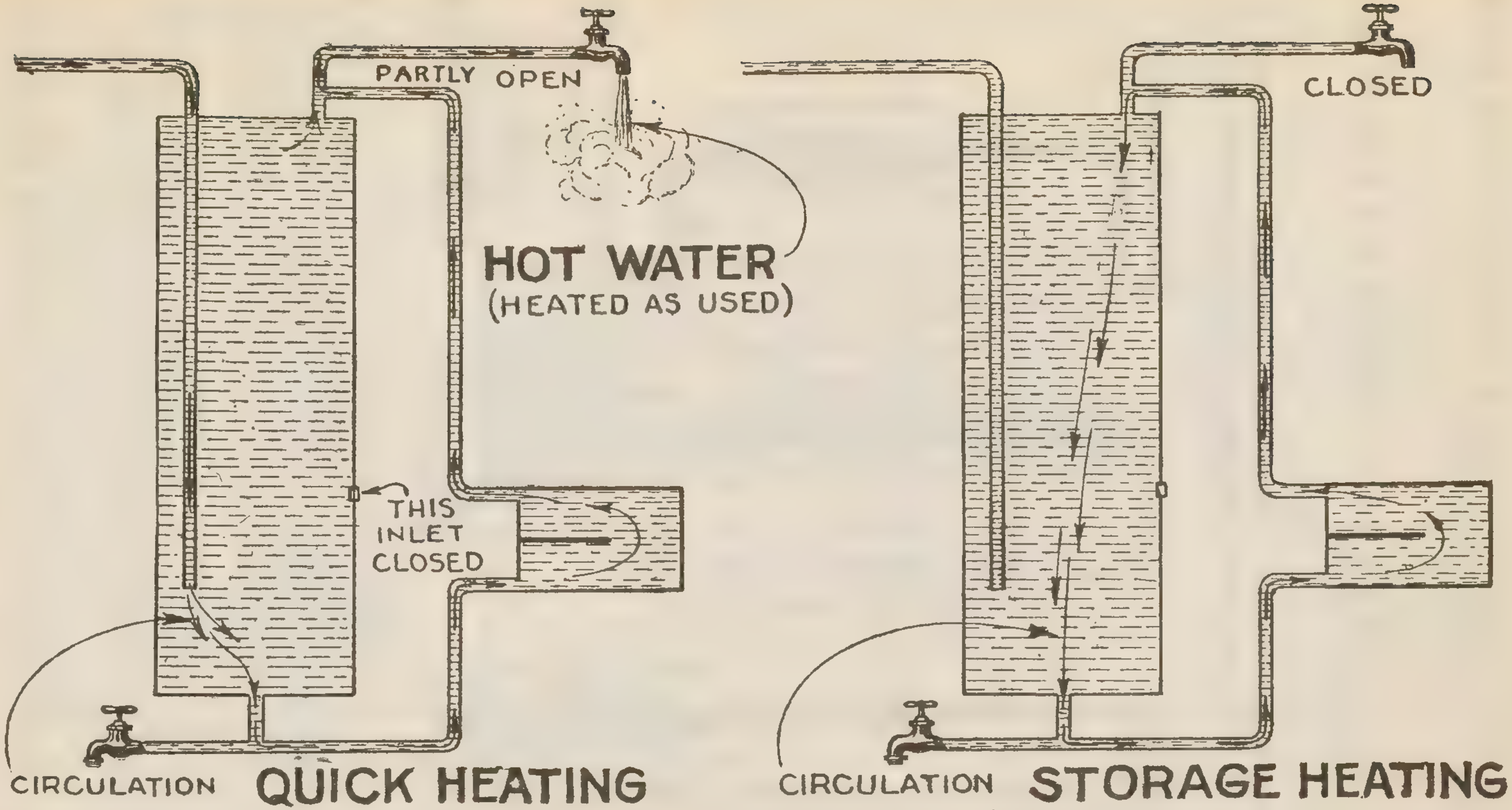


FIGS. 6,604 and 6,605.—Effect on circulation of the height of the riser or hot flow pipe. Fig. 6,604 shows ordinary connection with riser entering at E, and fig. 6,605, extended connection continued to top at W. Suppose sufficient heat be transmitted through the water back in each case as to give a mixture of half water, half steam. Now approximate pressure at K, due to the two foot column of water and steam in riser = .43 + 0 = .43 lb. per sq. in. (since 1 ft. head of water = .43 lb. per sq. in., and disregarding weight of the steam which is very small). Now downward pressure at P, due to a similar column of solid water = 2×.43 = .86 lbs. per sq. in. Hence unbalanced force tending to cause circulation is the difference in weight of these columns or .86 − .43 = .43 lbs. per sq. in. In the case of the extended riser connection in fig. 6,605, pressure at M, due to water and steam in riser = .43×(6÷2) = 1.29 lbs. per sq. in.; pressure at S, due to a similar column of solid water = .43×6 = 2.58 lbs. per sq. in. Unbalanced force tending to produce circulation is 2.58 − 1.29 = 1.29 lbs. per sq. in. Thus, with a 6 foot riser, the circulation force is 3 times that with the 2 foot riser, from which it follows that *the velocity of circulation is proportional to the length of the riser*. The additional head R, due to water back augments the unbalanced force causing circulation but as it is the same in each case need not be considered.



FIGS. 6,606 and 6,607.—Effect of elevation of water back on circulation. Fig. 6,606, water back placed at low point; fig. 6,607 water back placed at some intermediate point. In fig. 6,606, with water back at low point, evidently a full length L, of riser is available for circulation. If now, the water back be placed at an intermediate point as in fig. 6,607 the riser will be shortened to some length F. Furthermore, the column of water in the vertical part of the return does not contribute to circulation because the weight of this column of rising water of height L, is balanced by an equal column L′, of descending water indicated partly by dotted lines. As a matter of fact column L, is actually heavier than L′, because it is colder hence, it not only does not con-tribute to circulation but actually opposes it. Of course this opposition as should be understood is extremely small.

It should be understood that, practically, the force causing circulation is generated only in the riser or the vertical portion of pipe between the water back and tank, hence, where the conditions permit,



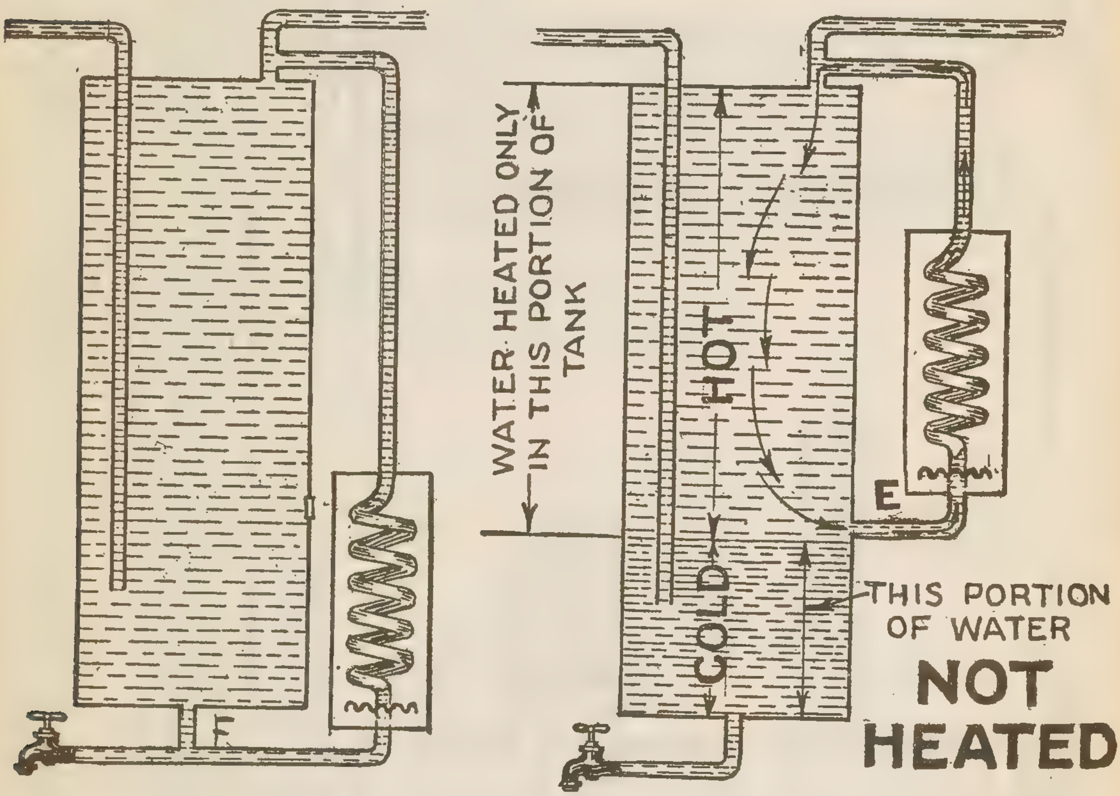
FIGS. 6,608 and 6,609.—Extended or long riser water back connection to storage tank showing circulation with faucet partly open and closed Evidently with this arrangement a small supply of hot water may be obtained before all the water is heated in the tank by partially opening the faucet. For best results a *flow tee* (such as shown in fig. 6,608) should be used with the long riser connection, otherwise a fully opened faucet will draw off water through the riser faster than can be heated in the water back. Fig. 6,609 shows circulation when faucet is closed, or for storage heating.

the heater should be located at the lowest point as shown in fig. 6,606 rather than at some intermediate point as shown in 6,607.

Figs. 6,608 and 6,609 show circulation of water with faucet partly opened, and closed, in a long riser installation.

The elevation of the heater with respect to the tank is important as before pointed out.

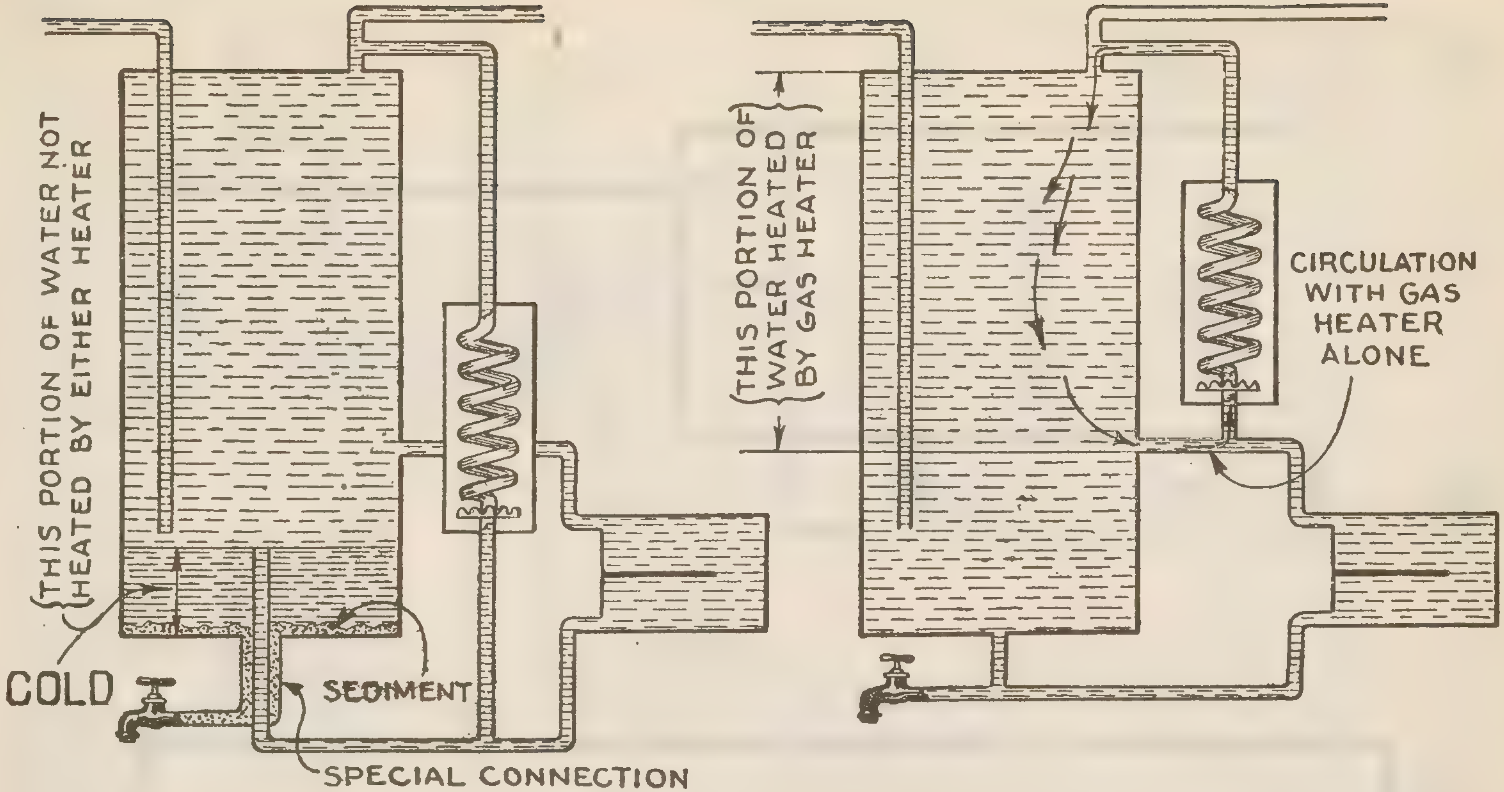
Where a heater is placed at an intermediate position, the amount of water heated will depend upon where the cold flow pipe is connected to tank.



FIGS. 6,610 and 6,611.—Low and intermediate point cold flow connection of heater giving full volume and part volume heating respectively. *When connected* at the low point F, evidently all the water in the tank will be heated, and when connected at an intermediate point E, only the water above the elevation of this point will be heated. The proper connection will depend upon conditions of service and upon whether one or two heaters be used.

When this connection is made at the low point as in fig. 6,610, all the water will be heated, but when connected higher up, as on to the hot flow inlet opening (E fig. 6,611) only a portion of the water will be heated.

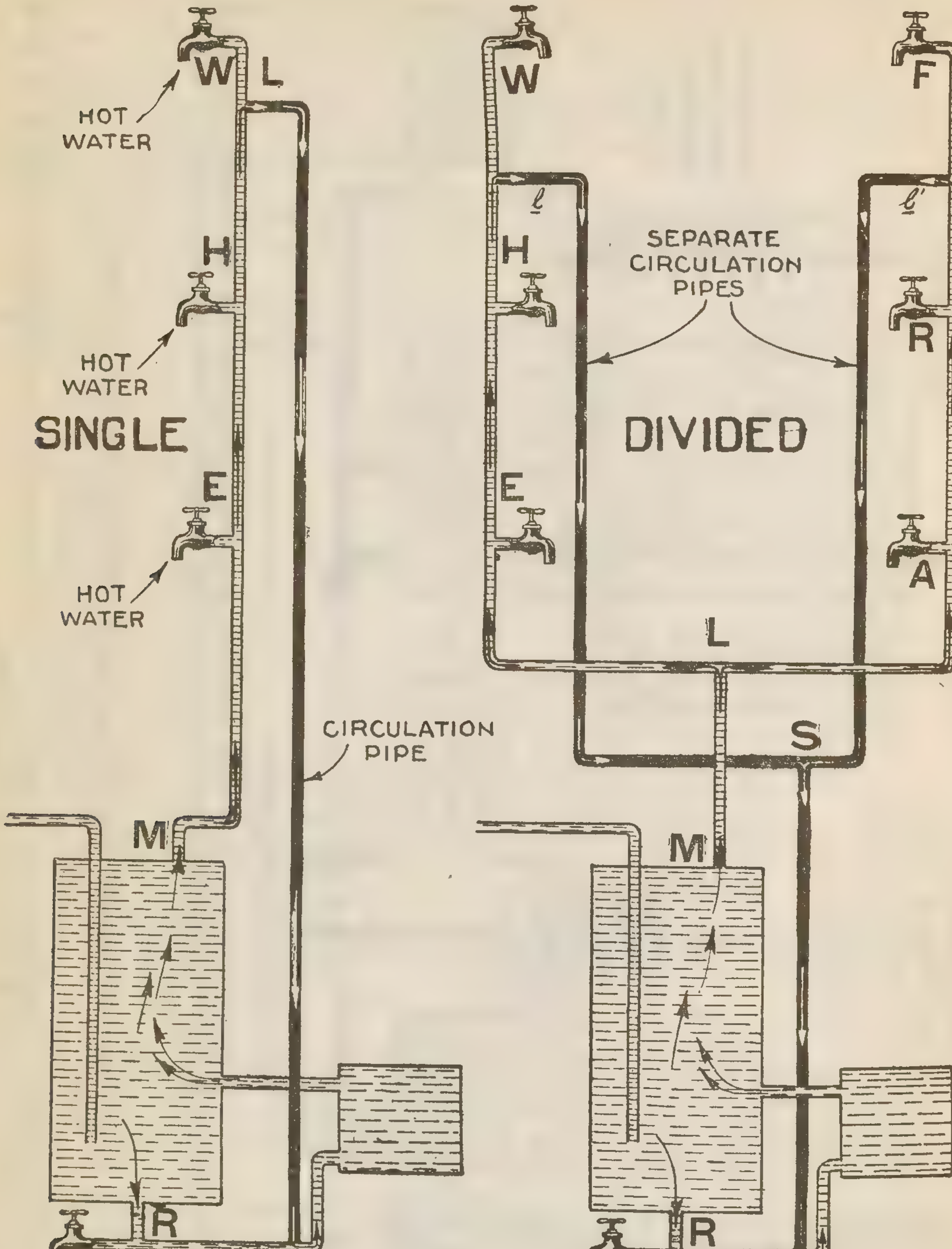
Where both a water back and a coil heater are provided,



FIGS. 6,612 and 6,613.—Combination coil and water back installation illustrating semi-parallel and semi-series connection. ***In deciding*** upon the method of connecting combination coil and water back heaters the conditions of service should be carefully considered.

they should be so connected as to increase the flexibility of the system.

Thus they may be connected as in fig. 6,612, giving semi-parallel flow, two volume heating, or as in fig. 6,613, giving a semi-series flow, two volume heating.



FIGS. 6,614 and 6,615.—Single and divided circulation pipe lines serving three and six faucets respectively. ***In operation*** (fig. 6,614) hot water leaves the tank at M, and rises through supply line serving faucets E,H,W, reaching high point L, and due to gradual lowering of temperature descends through return or *circulating pipe* to low point of tank, entering at R.

In order to obtain full volume heating without exposing the surface of the heater to sediment, the author's cylindrical mud drum as shown in fig. 6,616 may be used to advantage, especially in the case of coil heaters having small bore coils.

Circulation Pipe.—In order to avoid the delay and waste of fuel due to drawing off a considerable quantity of water before it will run hot, a continuous circulation between the boiler and up to the various faucets is provided by means of a circulating pipe.

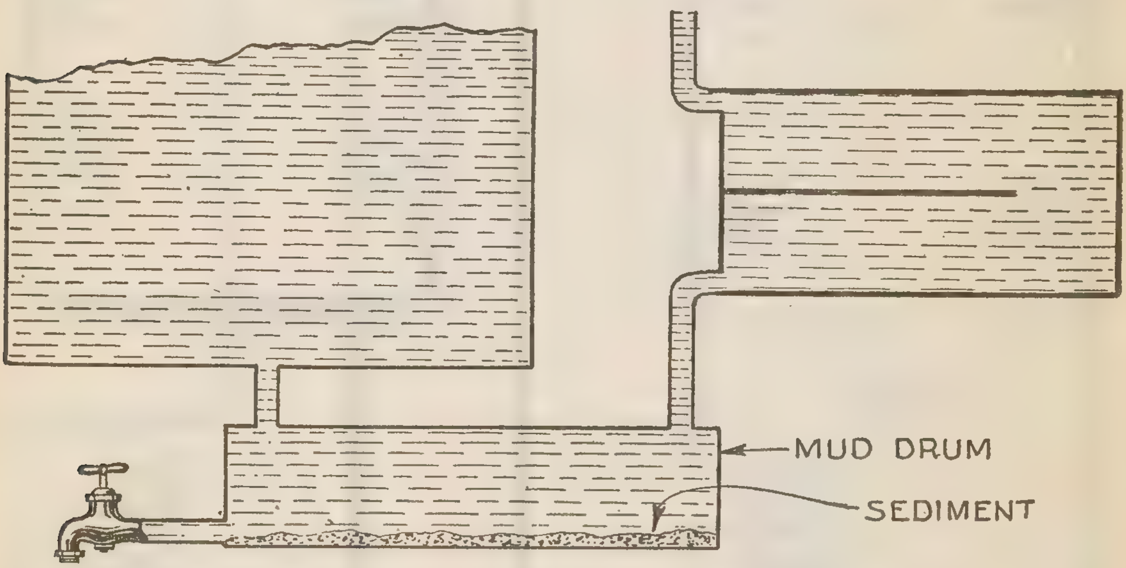


FIG. 6,616.—The author's cylindrical mud drum arrangement which avoids the use of the internal sediment pipe (shown in fig. 6,612) giving full volume heating and clear water cold flow.

Fig. 6,617 shows a single circulation pipe serving three faucets on different floors, and fig. 6,618, divided or separate pipes forming a U-shaped return.

Various other forms are shown in figs. 6,619 to 6,622. As can be seen,

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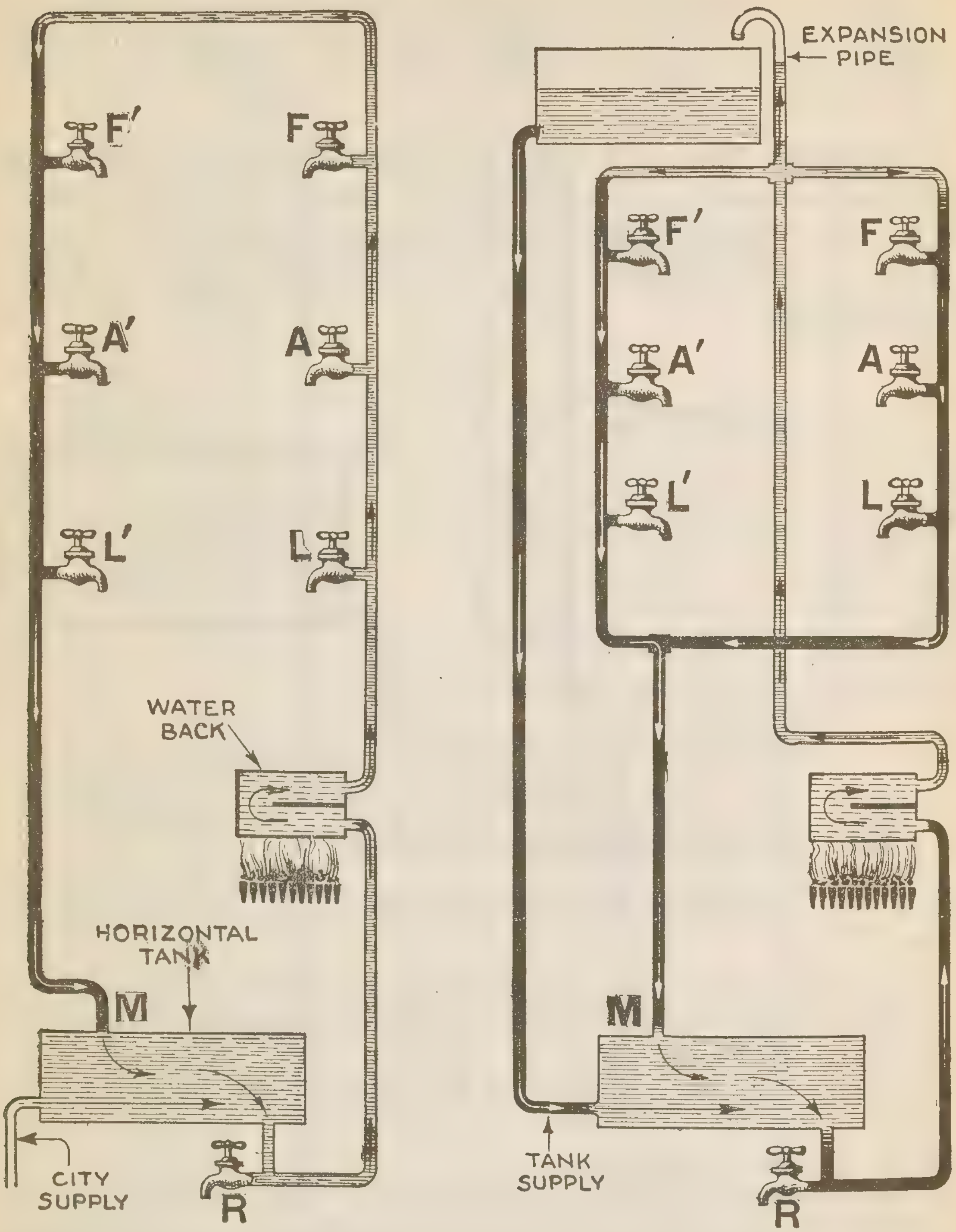
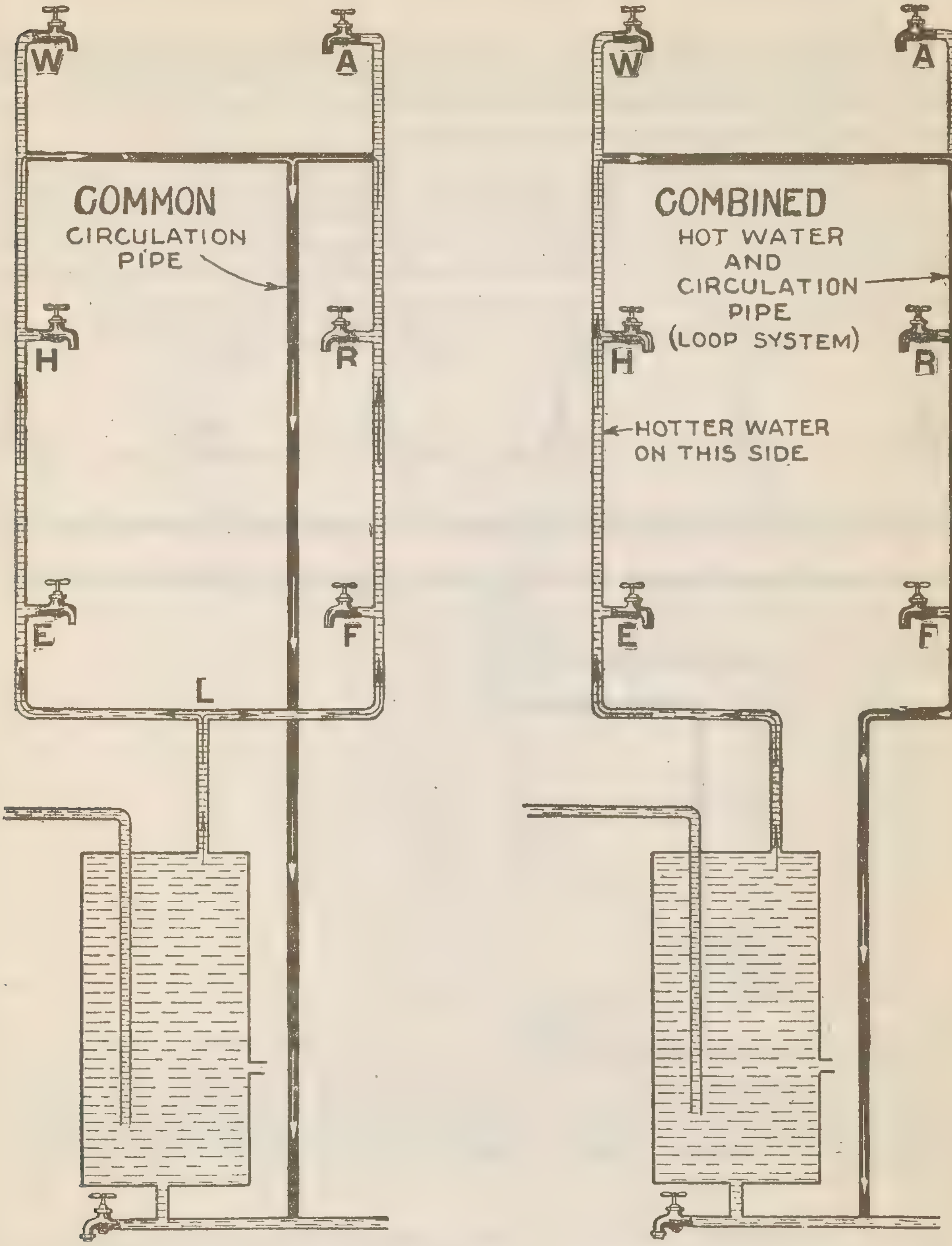
Figs. 6,614 and 6,615—*Text continued.*

In fig. 6,615, similar conditions obtain, hot water leaving tank at M, rising to dividing point L, thence through supply pipes serving faucets E,H,W, and A,R,F, to high points *ll'*, and returning through separate circulation pipes uniting at L, and at entering tank at R. The arrow in each figure indicates the flow and the solid black pipes the return or circulating pipes.



FIGS. 6,617 and 6,618.—Horizontal storage tank in basement heated by range on floor above. Fig. 6,617, tank supplied from city main, single circulation pipe line; fig. 6,618, supply from attic tank, divided circulation pipe line, showing expansion pipe.



FIGS. 6,619 and 6,620.—Common circulating pipe and combined supply and circulating pipe serving faucets E,H,W, and A,R,F. In fig. 6.619, the circulation temperature for each pair of faucets as W, A, is the same because the supply divides at L. In fig. 6,620, one side will be hotter than the other, the temperature gradually falling along the line, hence, much more water must be drawn off through faucet F, than through faucet E, to obtain hot water. This is a most unsatisfactory arrangement and has nothing in its favor except a saving in pipe.

the particular method employed will depend principally upon the location of the various faucets and whether the erector be liberal or stingy in the use of pipe. The illustrations should be carefully studied to avoid mistakes and resulting unsatisfactory operation.

By an inspection of the figures, it can be clearly seen that there is a continuous circulation of water through the system whether any faucet be opened or closed. Hence when a faucet is opened, hot water is at once obtained. Although some of the fuel used is spent in obtaining this circulation, the waste of fuel is considerably less than it would be in the absence of a circulating pipe, when considerable water must be drawn

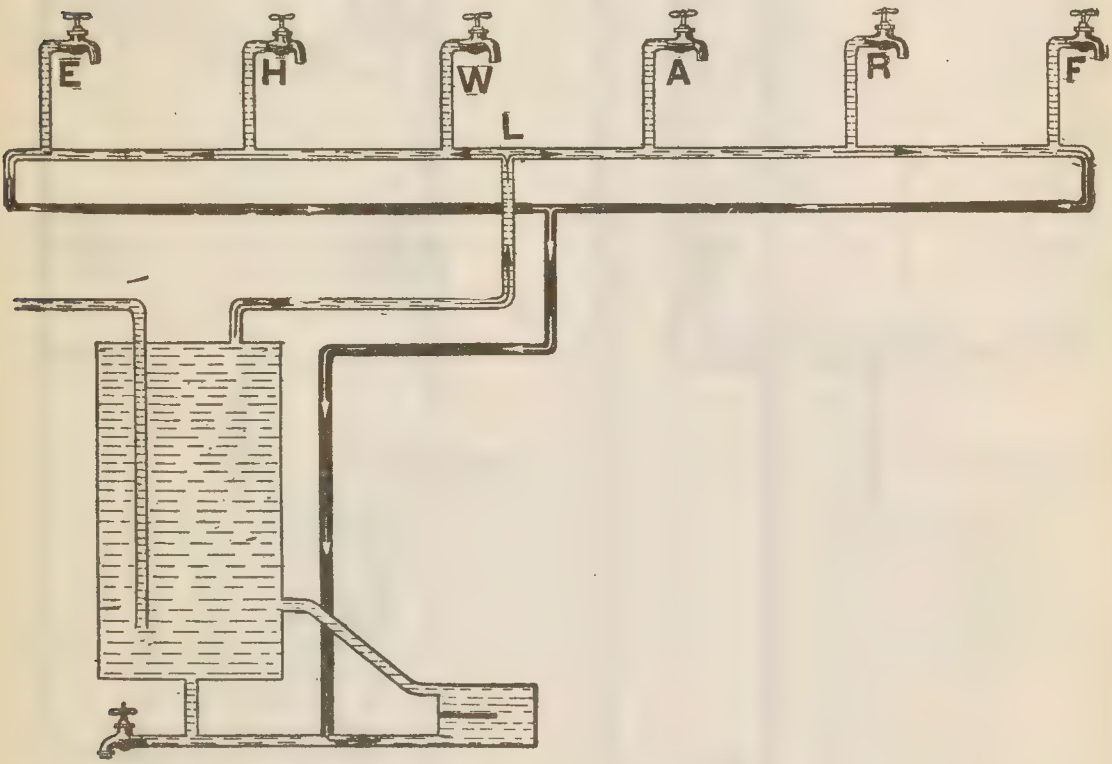


FIG. 6,621.—Loop arrangement of circulating pipe where all faucets are on the same flow tank at side. The supply pipe divides at L, and the two arms serving faucets E,H,W, and A,R,F, should be horizontal to avoid air pockets. The circulation is plainly indicated by the arrows.

off before hot water is obtained. The saving will depend upon the number and location of faucets, and upon the conditions of use.

A general principle upon which all correct installations are based is that *the water should flow direct to the high point and*

from there descend to the low point; in other words, no part of the pipe should be pitched for down flow between boiler and high point, and no part of the return should be pitched for up flow between high point and low point or cold flow inlet.

Tappings on Top Head of Vertical Tanks.—Usually two

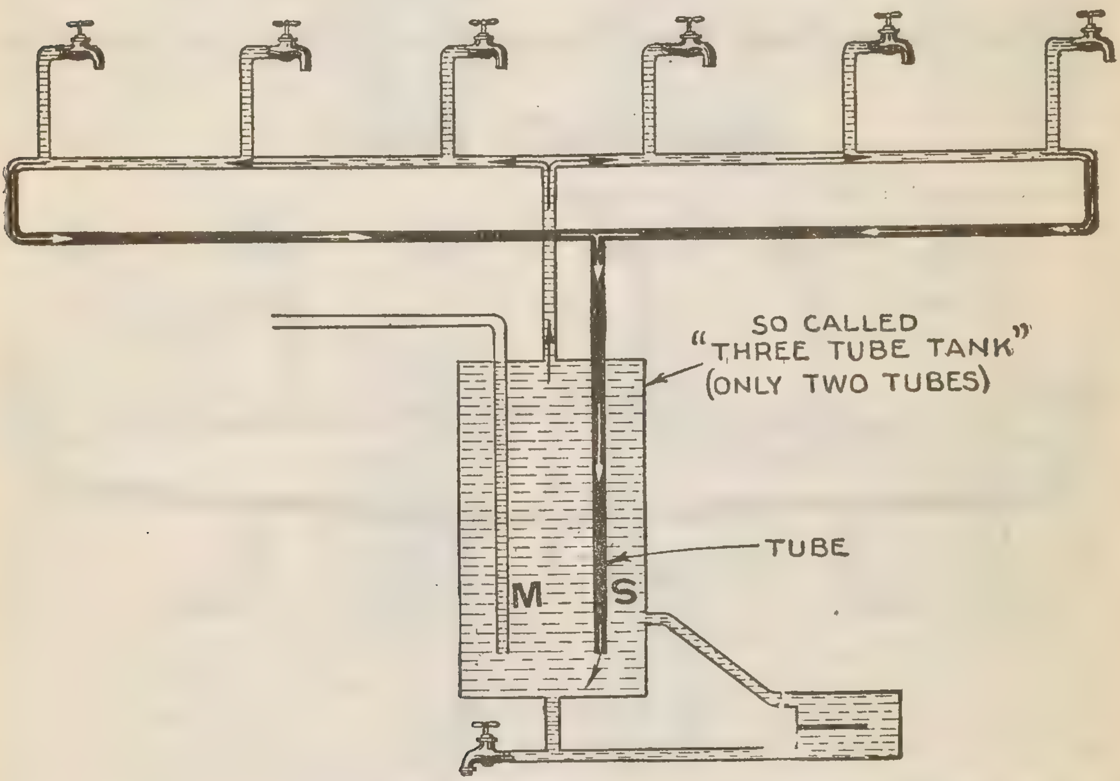


FIG. 6,622.—Loop arrangement of circulating pipe where all faucets are on the same floor, tank at center, illustrating the piping of a so called *three tube tank*. In the tank there are two tubes; supply tube M, and circulation return tube S, both discharging near bottom of the tank. The operation of the system needs no explanation; however, the erroneous name "three tube tank" is due to the fact that three *pipes* are connected to the top of the tank and because very few mechanics know the difference between a *tube* and *pipe;* the distinction should be carefully noted as explained in the text. The tank is properly called a *two tube tank*.

taps are provided, one for the cold water supply and the other for the hot water supply. The usual arrangement is shown in fig. 6,624 and a more efficient one thermally in fig. 6,625. Where a circulation pipe is used, the three tap,

erroneously called two tube, arrangement shown in fig. 6,626 is convenient as it saves an extra fitting. For multi-faucet installations, 4 taps, fig. 6,627 are sometimes used. Tanks may be obtained with any number and arrangement of tappings. Tappings in excess of four (altogether) are customarily charged extra.

Flow Tee on Long Riser Connection.—Where the hot flow

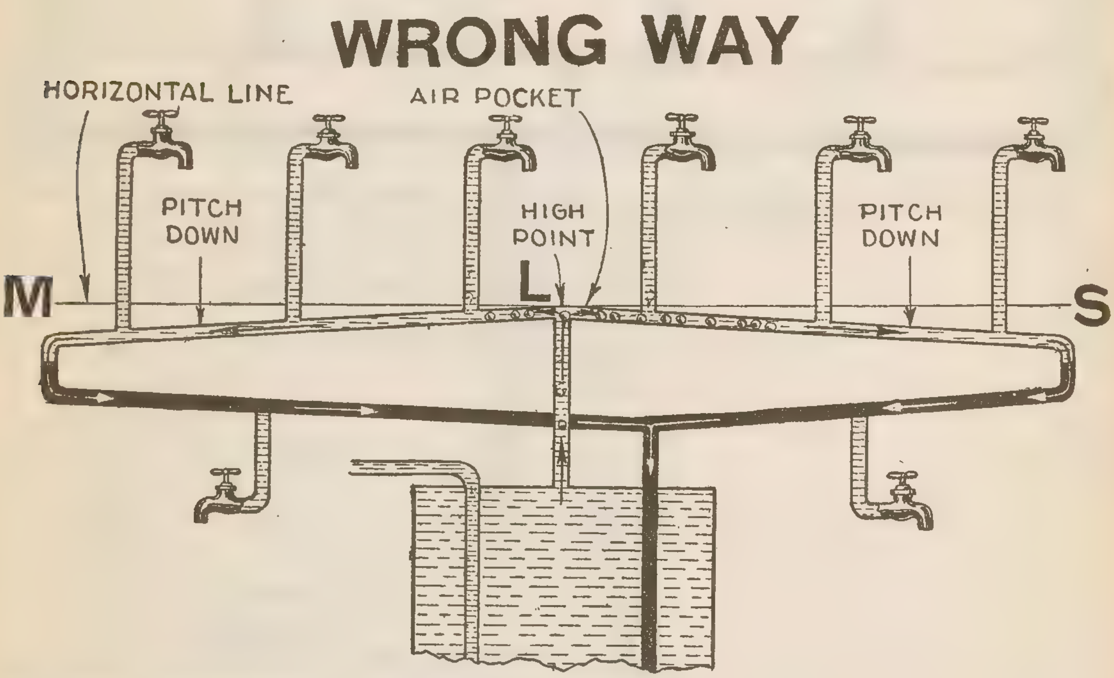
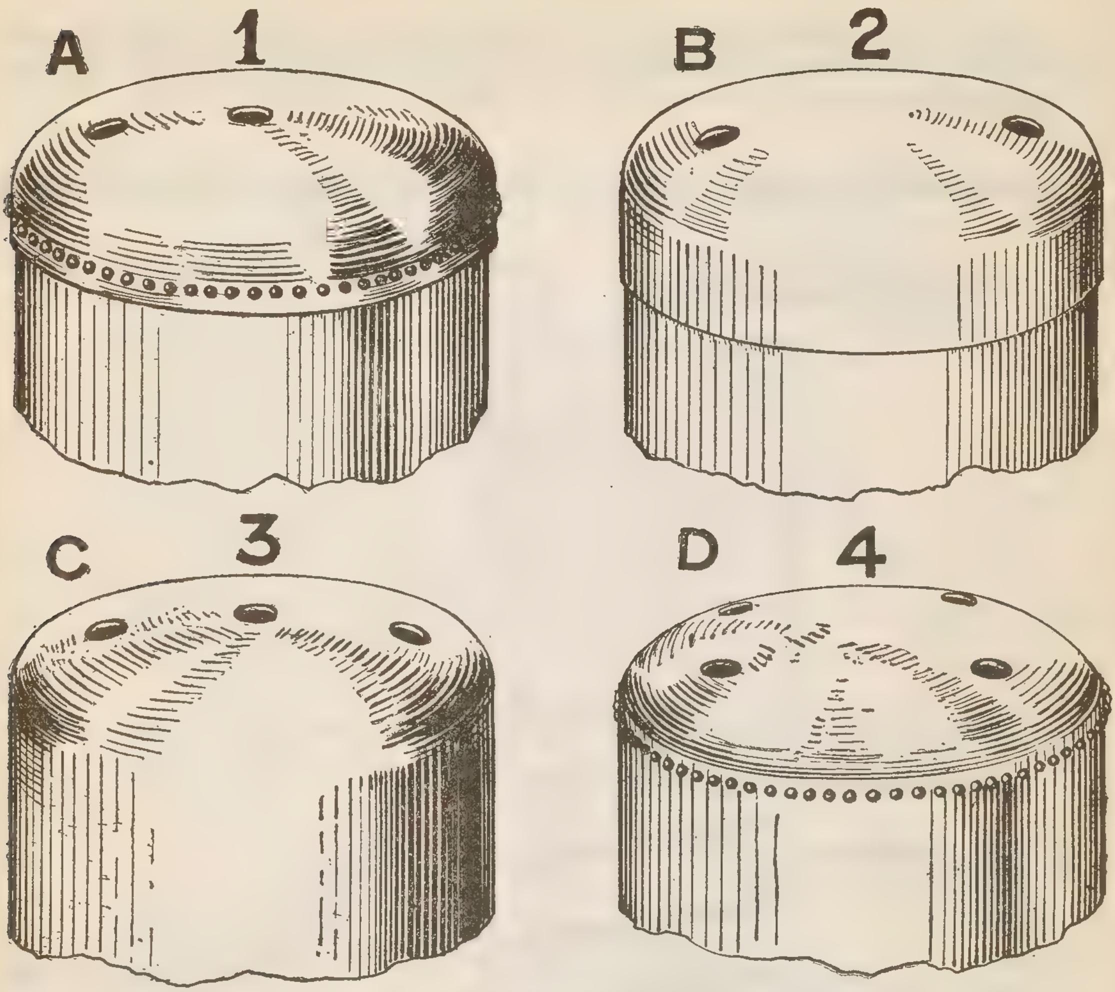


FIG. 6,623.—***Wrong way*** of piping loop circulation serving one floor. The two supply arms, LM and LS, should be horizontal instead of inclined to prevent the formation of air pocket at L, with resulting disagreeable ejection of air from the faucets when turned on.

pipe or riser from water back is extended and connected with the hot water supply pipe, a special flow tee should be used as shown in fig. 6,628. The object of this tee is to cause the water drawn out of tank to be taken from the supply at the top of the tank rather than from the riser.

Evidently from the illustration it is clear that the flow is direct and easy from tank to hot water supply pipe, and difficult for flow from the riser,



FIGS. 6,624 to 6,627.—Various tapping arrangements for storage tank tops. **A,** two tap center and offset, most common method; **B,** two taps, both offset, best for thermal efficiency; **C,** three taps, so called three tube; **D,** four taps—this arrangement is sometimes desirable on large installations where there is a multiplicity of faucets.

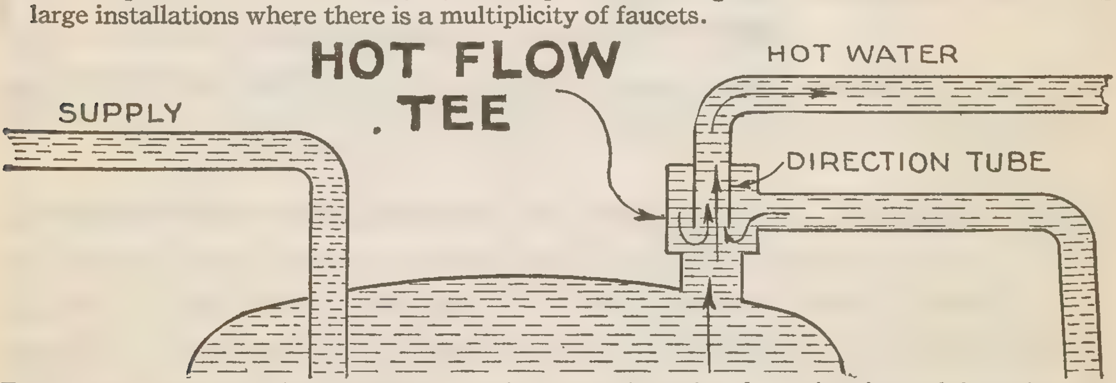


FIG. 6,628.—Flow tee for hot water supply connection when long riser is used from heater. *Evidently,* as indicated by the arrows, such device will permit hot water to be drawn from top of tank with the minimum short circuiting from riser.

because water flowing out of riser would have to reverse its direction on account of the direction tube, which extends down into the tee past the riser connection.

Horizontal Storage Tanks —Frequently there is not sufficient

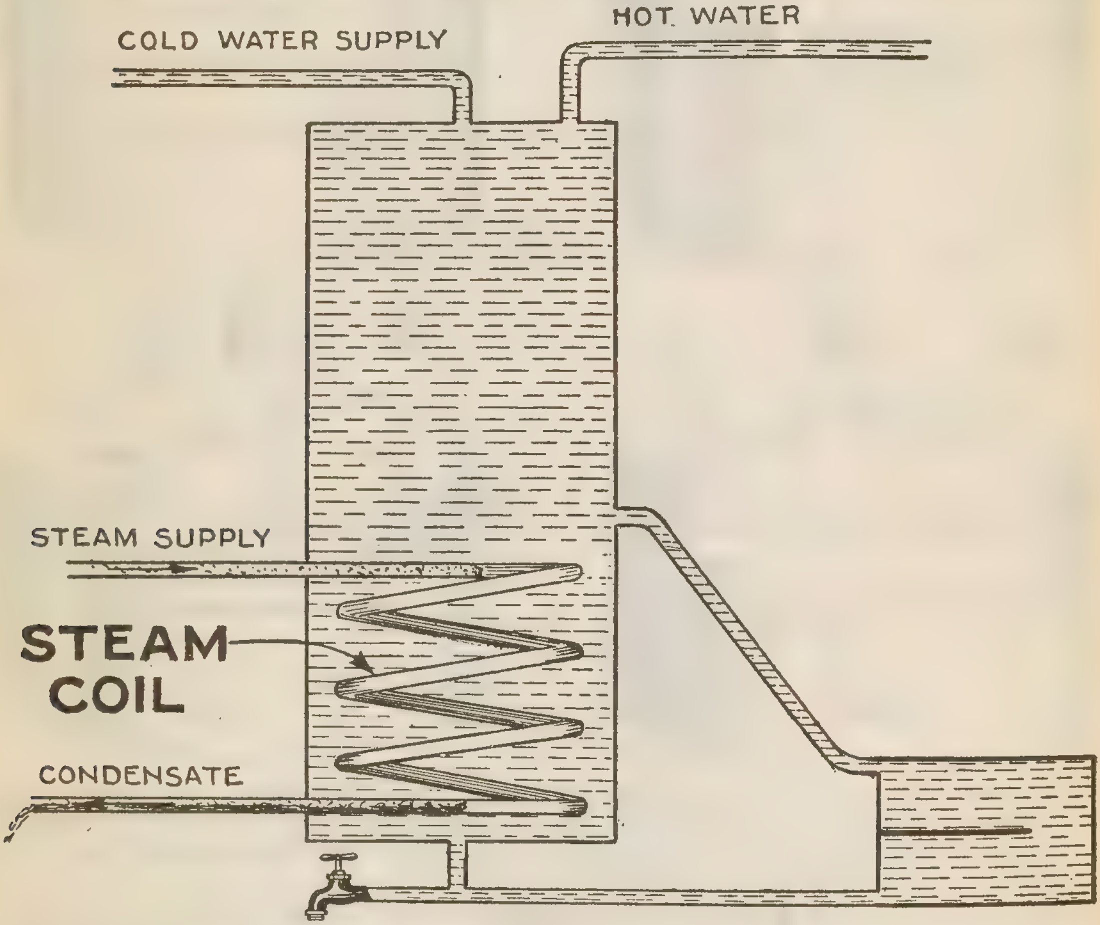


FIG. 6,629.—Storage tank having internal steam coil heater. Where there is a supply of steam this is a desirable feature, the coil may be used as an auxiliary heater in combination with a water back, or as a main heater depending upon the amount of steam available.

space available between floor and ceiling for a vertical tank, and in such case a horizontal tank or a vertical tank used as a horizontal tank is installed. The same principles that were given for vertical tanks hold for horizontal tanks and if these be understood and applied the usual mistakes made in connecting horizontal tanks will be avoided.

A regular horizontal tank is the same as a vertical tank, but is provided with tappings properly located for horizontal setting.

The general arrangement of these tappings is shown in fig. 6,630, and the

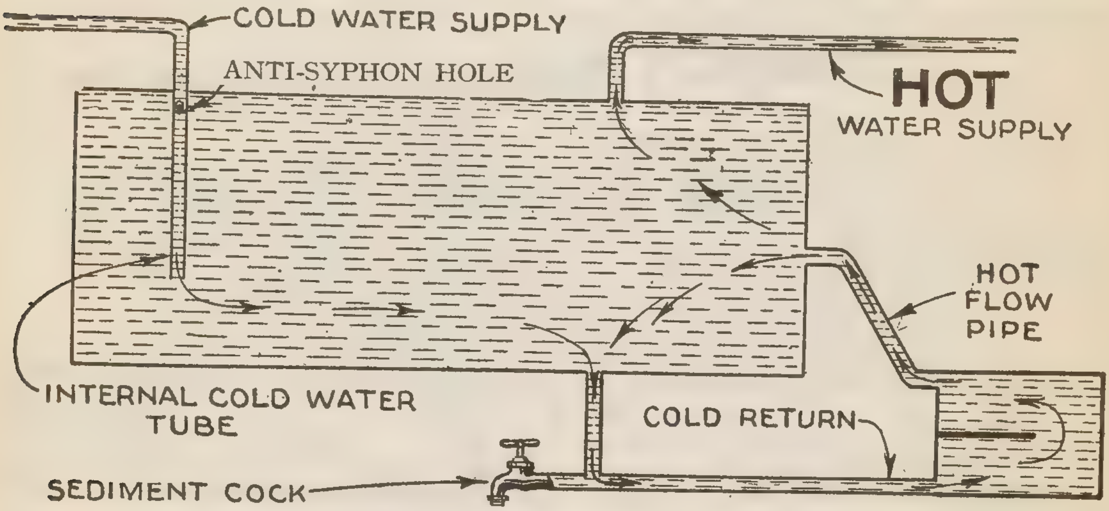


FIG. 6,630.—Usual method of connecting a horizontal storage tank showing circulation.

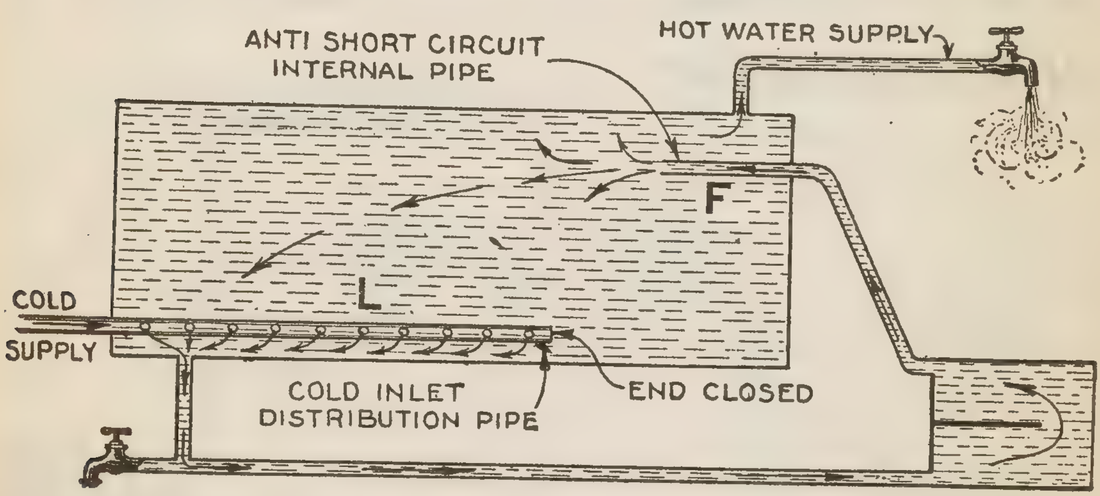


FIG. 6,631.—Author's method of connecting horizontal storage tank for minimum short-circuiting between the cold and hot water. The cold inlet distribution pipe L, divides up the flow of the incoming cold water and directs it to the bottom of the tank in the general direction of the cold flow outlet. The anti-short circuit internal pipe F, prevents hot water coming in from the hot flow pipe passing directly up and going out through the hot water supply pipe when water is being drawn through faucet. The reason for this is because on heavy demand, the water back cannot heat the water fast enough and consequently relatively cold water would mix with the hot water going out, thus cooling off the supply.

author's arrangement employing distribution and anti-short circuit tubes, in fig. 6,631.

It is easy to make mistakes in setting horizontal tanks, as shown in figs. 6,632 and 6,633.

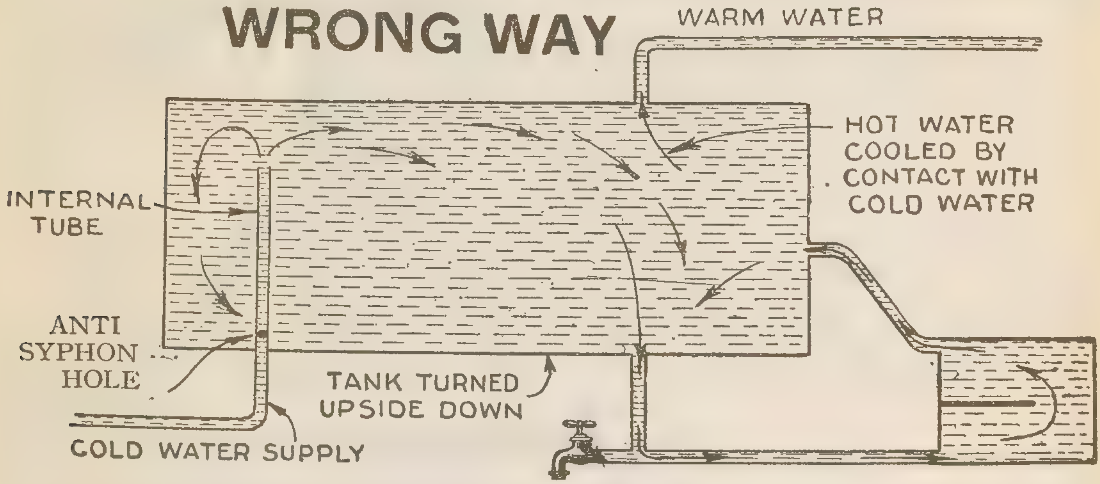


FIG. 6,632.—*Wrong way* of connecting horizontal storage tank I: *boiler upside down.* The incoming cold water is discharged at top of tank where it will mix and cool off the hot water.

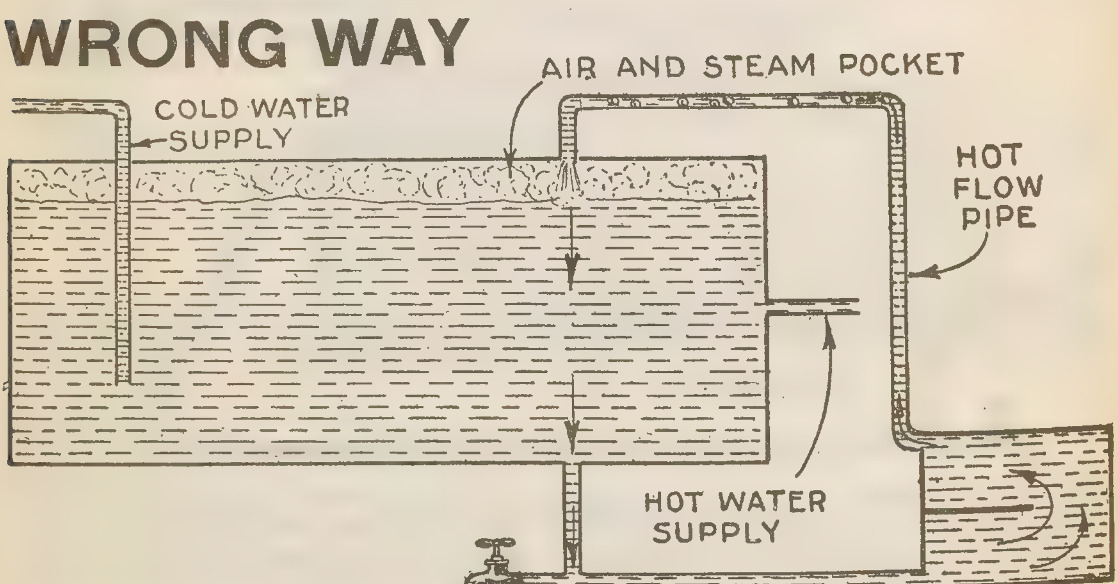


FIG. 6,633.—*Wrong way* of connecting horizontal storage tank II: *hot flow pipe enters too high and hot supply taken too low.* Evidently there is no way to purge the tank of air and steam; this will result in rumbling and reduced capacity of boiler.

These wrong settings should be carefully noted so as to avoid mistakes with resultant unsatisfactory operation.

The right way to connect up a vertical tank used as a horizontal tank is shown in fig. 6,634 and one of the numerous wrong ways in fig. 6,635.

Battery of Storage Tanks.—On large installations where there

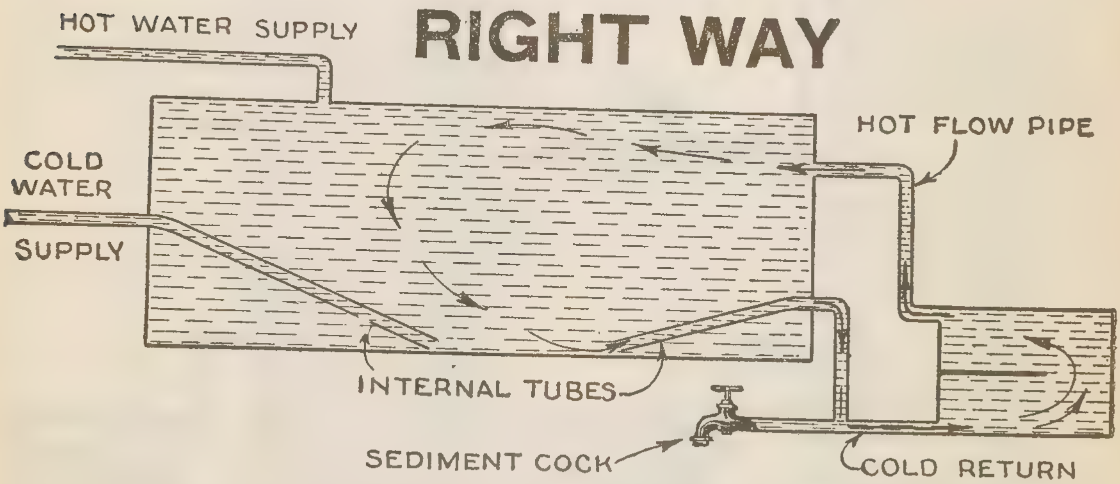


FIG. 6,634.—***Right way*** of connecting vertical tank used as a horizontal tank. ***Note*** internal tubes causing cold water to be discharged at bottom of tank and cold return to be taken from bottom.

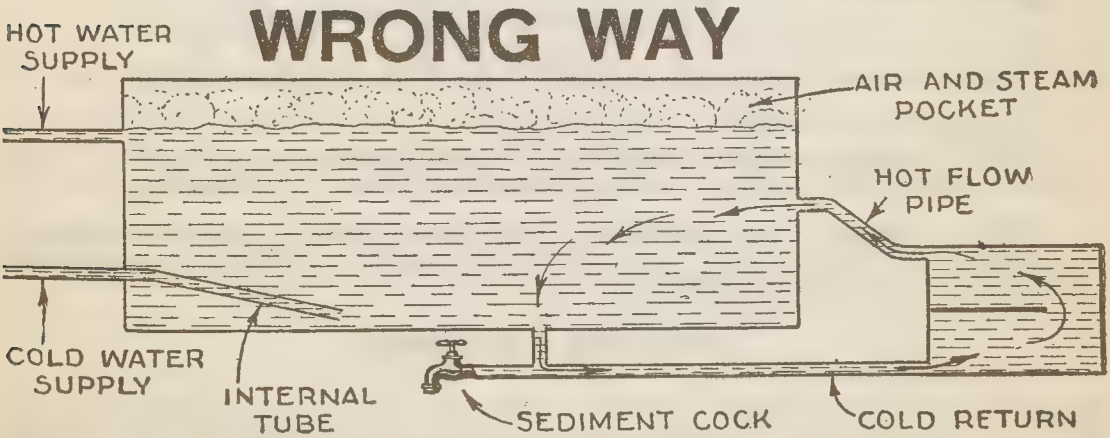


FIG. 6,635.—Wrong way of connecting vertical tank used as a horizontal tank. ***Note*** large air and steam pocket formed because the hot water supply is not taken from the top.

is not enough room vertically for a single tank large enough to serve the installation, two or more tanks operating together may be used; there are various ways of combining the tanks, two methods being shown in figs. 6,636 and 6,637.

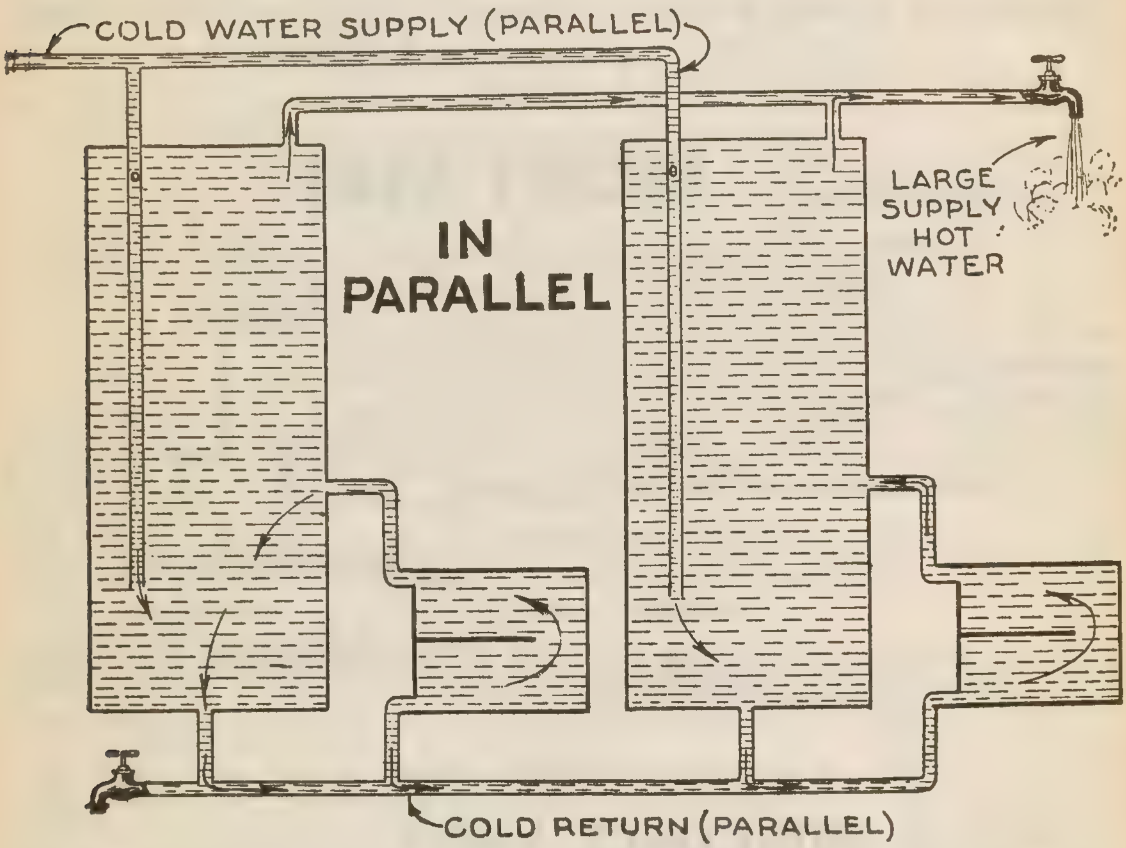


FIG. 6,636.—Two tanks connected ***in parallel*** for *large supply of* ***moderately hot*** *water.*

NOTE.—***To find capacity of tanks*** any size, give dimensions of a cylinder in inches, to find its capacity in U. S. gallons: square the diameter, multiply by the length and by .0034.

NOTE.—***The size of hot water tanks*** for apartment houses is usually proportioned to the number of families supplied. When water is to be supplied for all domestic purposes, the capacity may be as in the table following.

Size of Hot Water Tanks

Capacity.......	250	325	400	475	600	700	1,000	1,250
Size............	6×30	8×30	10×30	8×36	10×36	12×36	12×42	12×48

Double Storage Tanks.—For installations in tall buildings requiring high pressure on the hot water supply line to reach the upper stories the expense of a large and heavily constructed storage tank is avoided by use of a double tank, consisting of a small high pressure tank, built within a larger low pressure tank as shown in figs. 6,638 and 6,639.

The inner tank supplies hot water at high pressure for the upper stories, and the outer tank serves the lower stories at

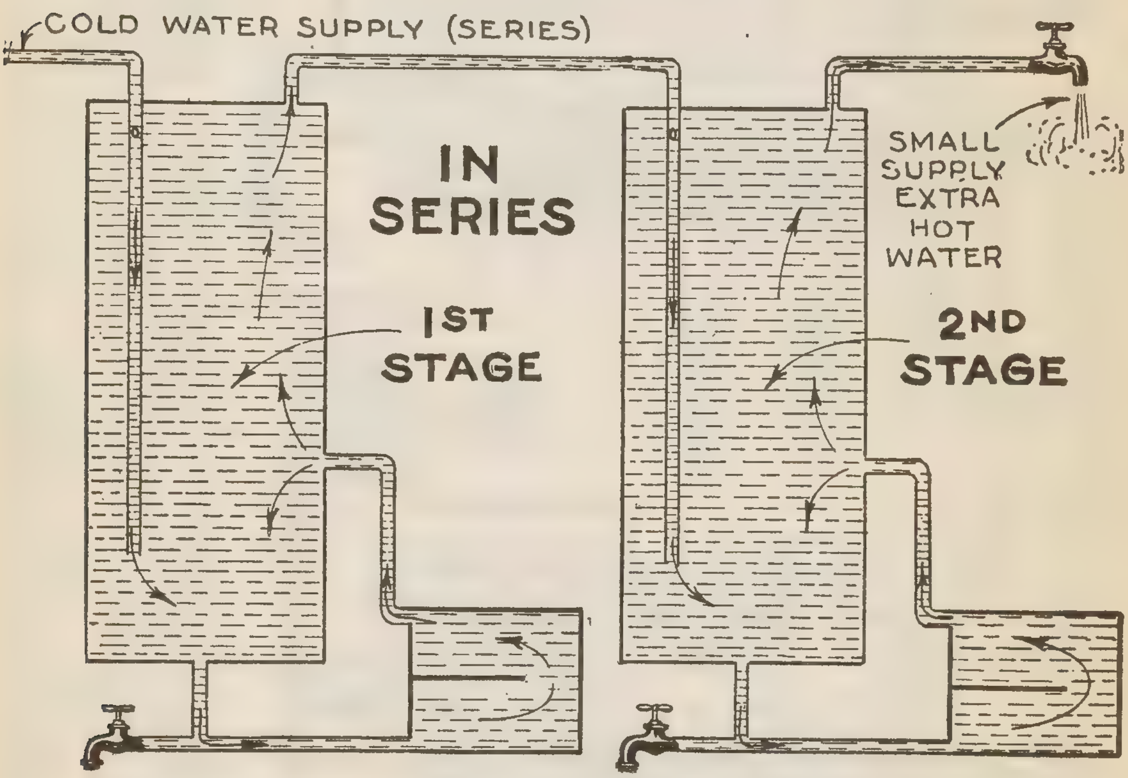


FIG. 6,637.—Two tanks connected in ***series for small supply of extra hot water.***

NOTE.—***The size of storage tank*** which should be employed for any particular work depends chiefly on existing conditions, such, for example, as the water supply and the nature of the building. A safe rule is to allow a 35 or 40 gal. tank for a building having one bath room, and to add 30 gallons additional capacity for every extra bath room.

NOTE.—***In practice*** it is found that about 100 sq. in. of water back heating surface in actual contact with the fire is sufficient to give good results with a 40 gal. tank, heavy water consumption, and with a 50 gal. tank with moderate water consumption.

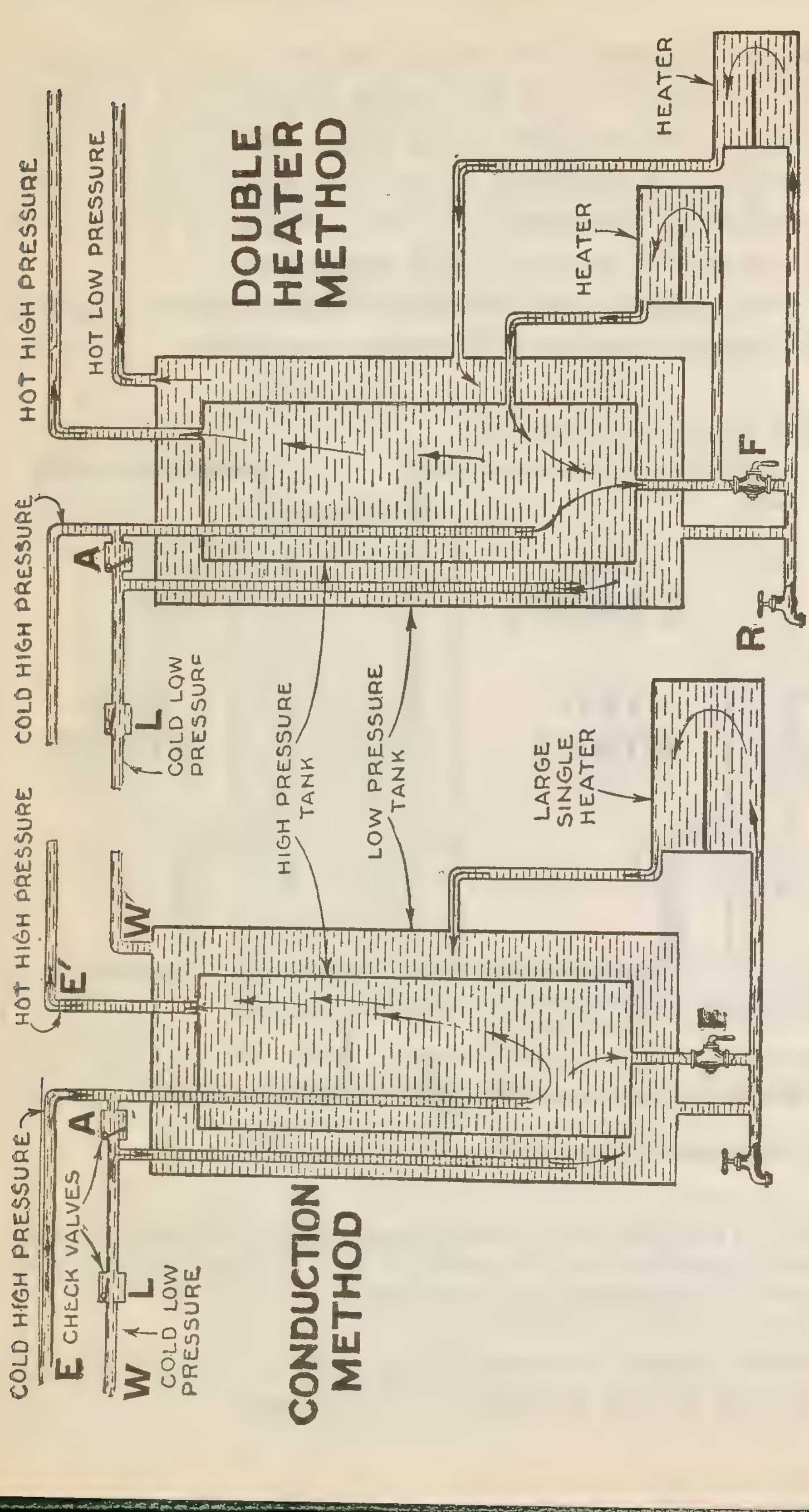


FIG. 6,638.—Double storage tank heated by the *conduction method*. E and W, are the high pressure cold supply and low pressure cold water supply lines respectively and E' and W', the high and low pressure hot water supply lines respectively. ***In operation***, as hot water is drawn from both lines, cold water enters the outer boiler through pipe W, lifting check valve L, and the inner boiler through pipe E, holding by excess pressure check valve A, closed. The water in the outer boiler is heated by a large single heater part of the heat thus supplied being transmitted conductively through the shell of the inner tank, heating the water therein.

FIG. 6,639.—Double storage tank heated by the double heater method. ***The general operation*** is the same as in fig. 6,638 except that a separate heater is provided for each tank instead of heating the water in the inner tank conductively.

low pressure. Since the inner tank is under pressure externally, it will withstand the high pressure necessary for the upper stories without undue stress in the shell.

The illustrations show the conduction and the double heater methods of heating the water.

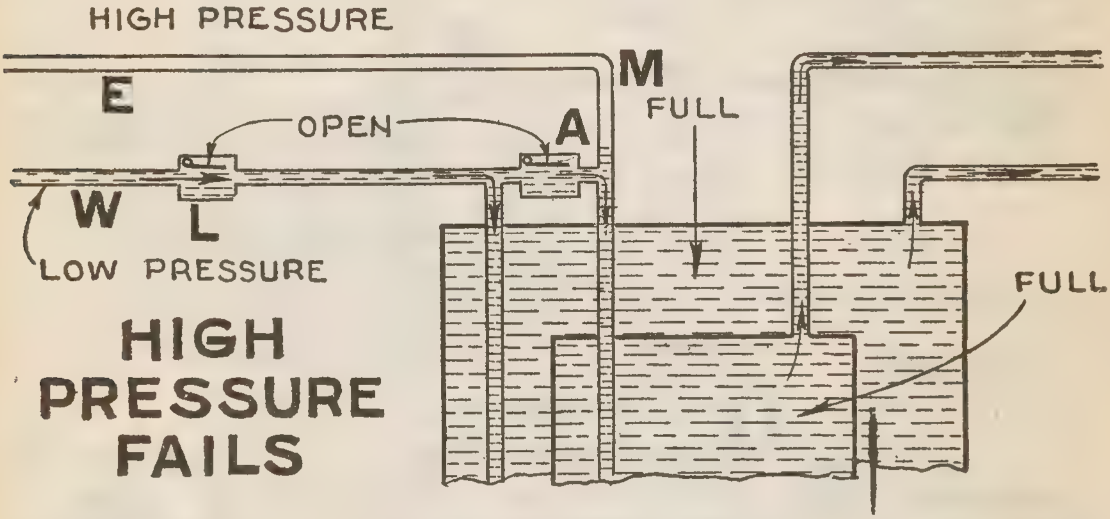


FIG. 6,640.—Operation of double tank system. *1. High pressure fails.* When this condition obtains as indicated by low level M, of water in high pressure supply pipe E, the pressure in pipe W, will cause check A, to open allowing the supply to flow into inner tank thus causing that tank to remain full.

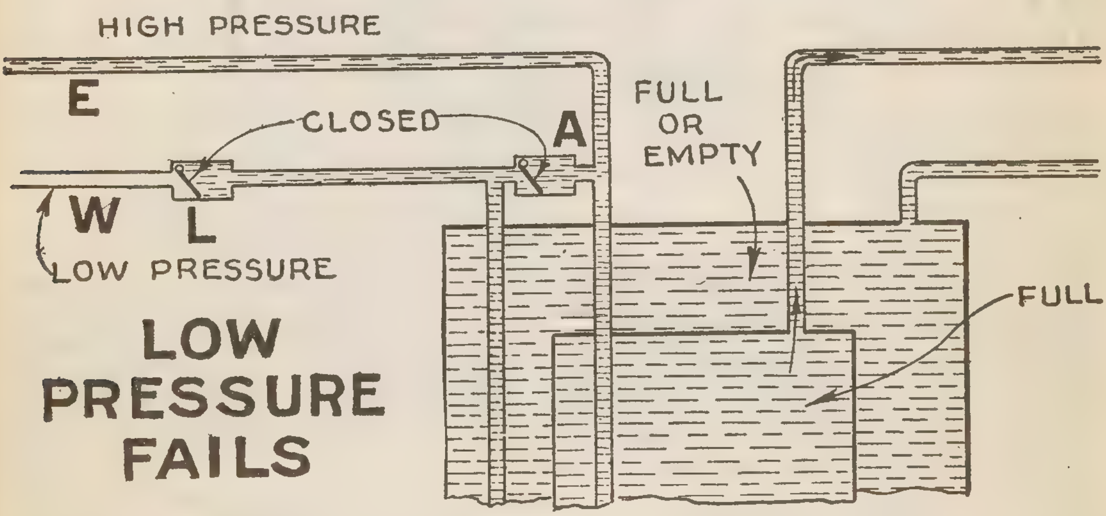
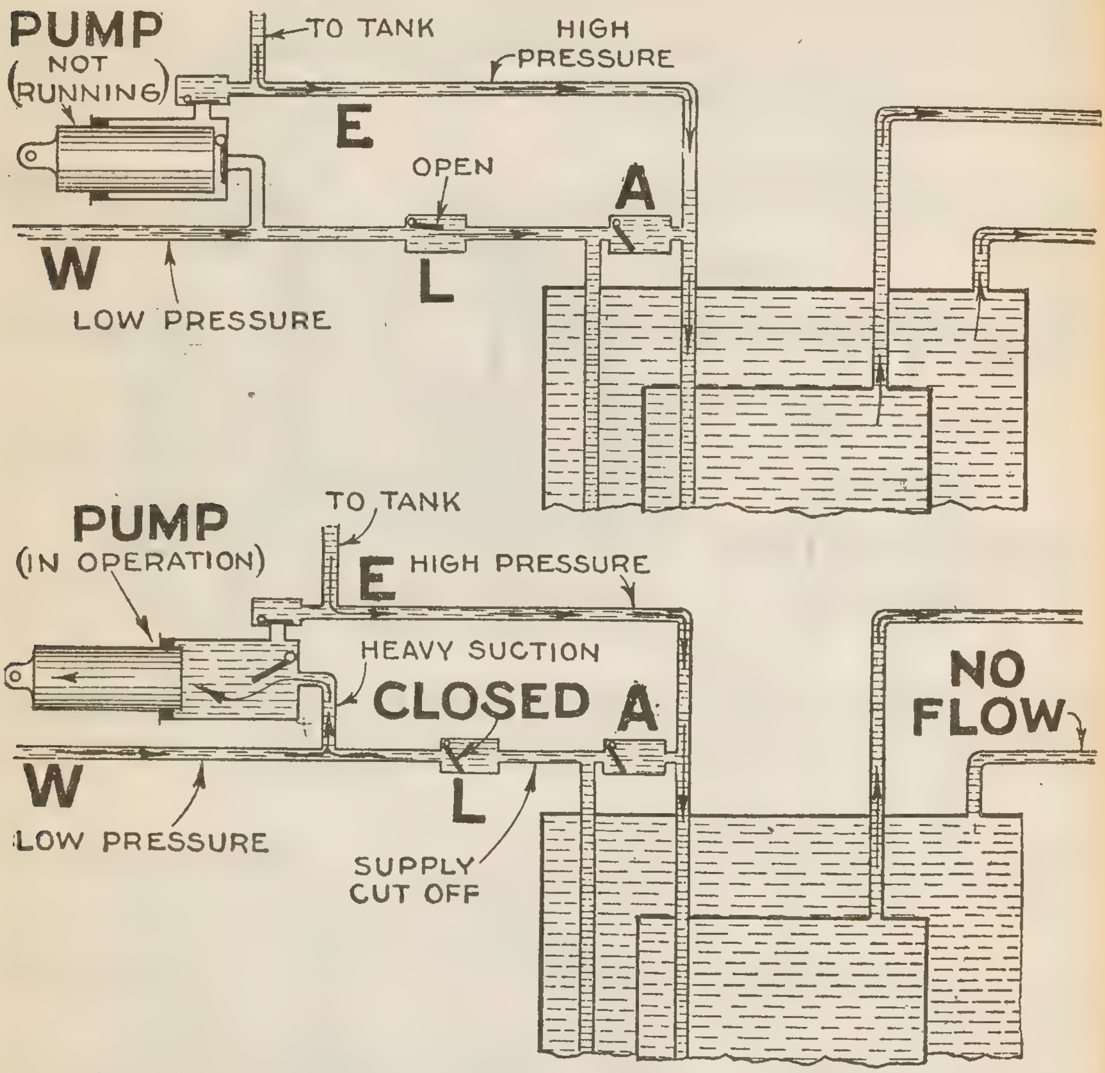


FIG. 6,641.—Operation of double tank system. *2. Low pressure fails.* When this condition obtains, the excess pressure in pipe E, will hold check A closed maintaining a full supply to the inner tank so that it will not collapse in case water remains in the outer tank.

An important precaution in the use of a double tank is that the inner tank should never be empty when there is water in



FIGS. 6,642 and 6,643.—Operation of double tank system. *3. Effect of pump operation supplying high ' ressure line tank.* When the tank is full and pump not running as in fig. 6,642, the high pressure in pipe E, will hold check A, closed against the low pressure in line W, which however, is sufficient to open check L, and supply water to the outer tank. Now, if the pump be started to replenish the water in the tank, the heavy suction *may* pull water out of line W, faster than the low pressure alone can supply it, hence, under such conditions the pump side of check L, will be subjected to a partial vacuum and will close, thus cutting off the supply to the outer tank as shown in fig. 6,643.

the outer tank because of danger ot collapse of the inner tank. This is rendered impossible by means of the check valves A

and L, and the placement of drain cocks F and R. The operation of the tanks is shown in the accompanying illustrations.

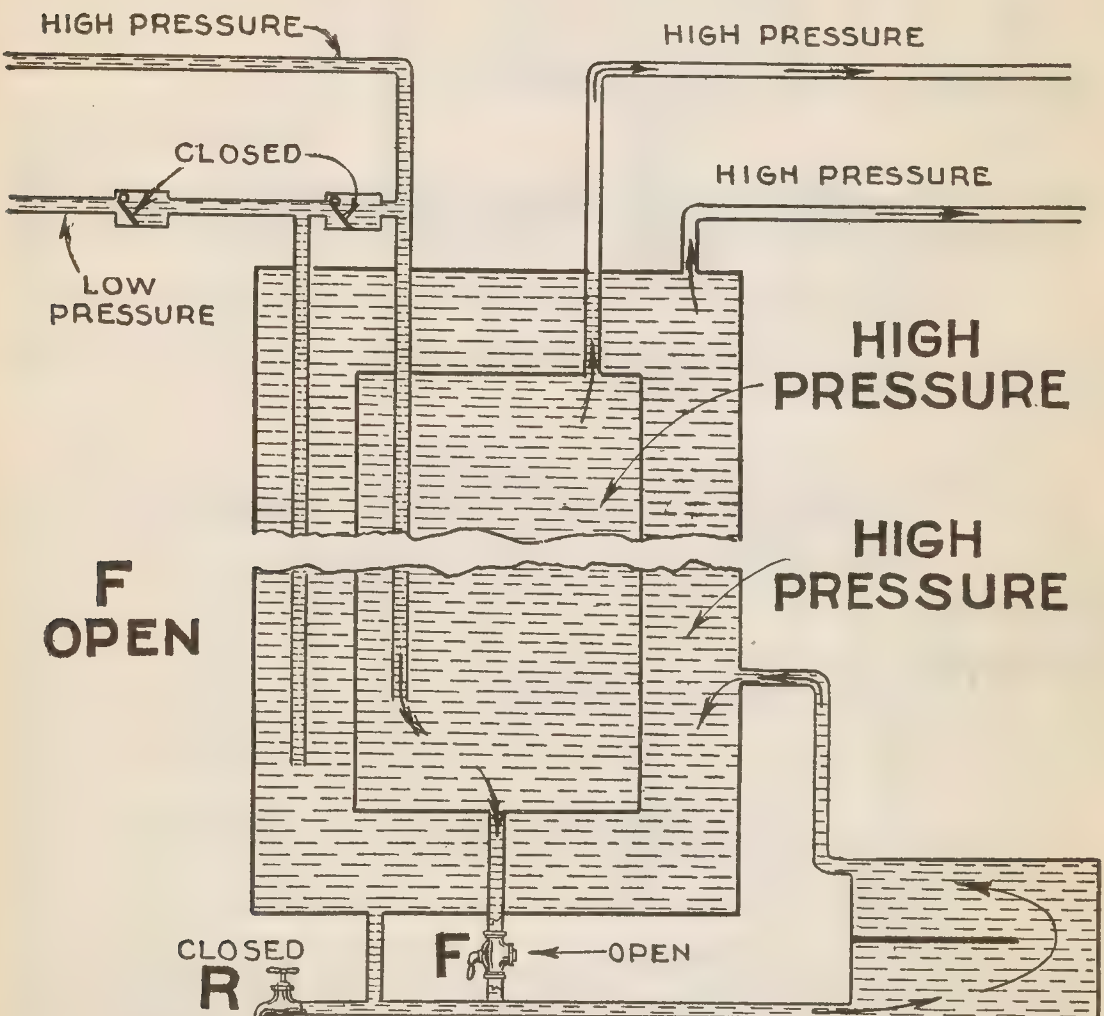


FIG. 6,644.—Operation of double tank system. *4. Drain cock F, to inner tank open.* Water cannot drain out of the tank simply by opening drain cock F. The circulation however, will be changed since the inner tank is put into communication with the water back, resulting in the water in the inner tank being heated by conduction and also by the water back in circulating through the latter.

NOTE.—When hot water tanks are to be heated by a steam coil placed inside of the tank, the size of the coil to be used can be determined, approximately, by allowing 15 gallons for each square foot of wrought pipe coil surface and 20 to 25 gallons for each square foot of brass or copper pipe coil surface. These proportions have been found to give good results in ordinary work.

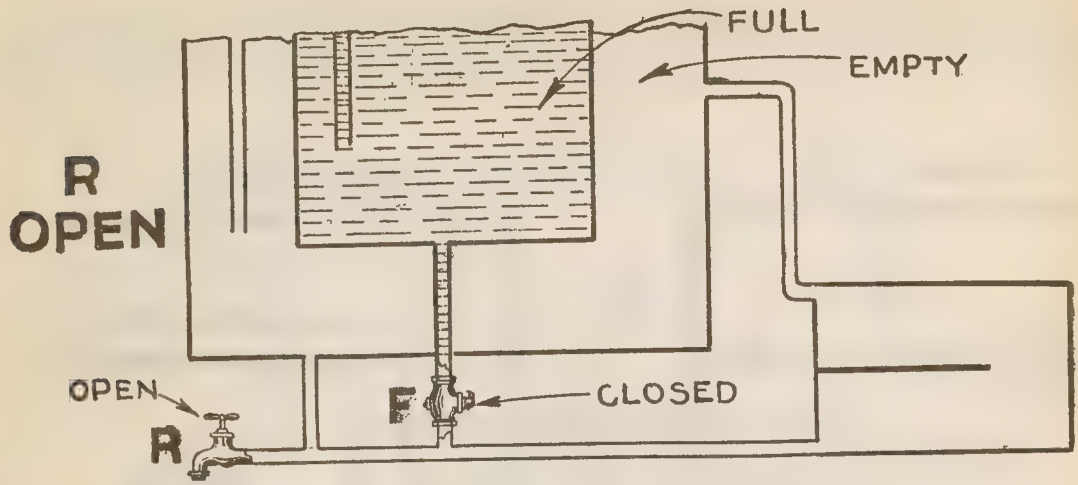


FIG. 6,645.—Operation of double tank system. *5. Drain cock R, open.* This will drain the outer tank independently of inner tank.

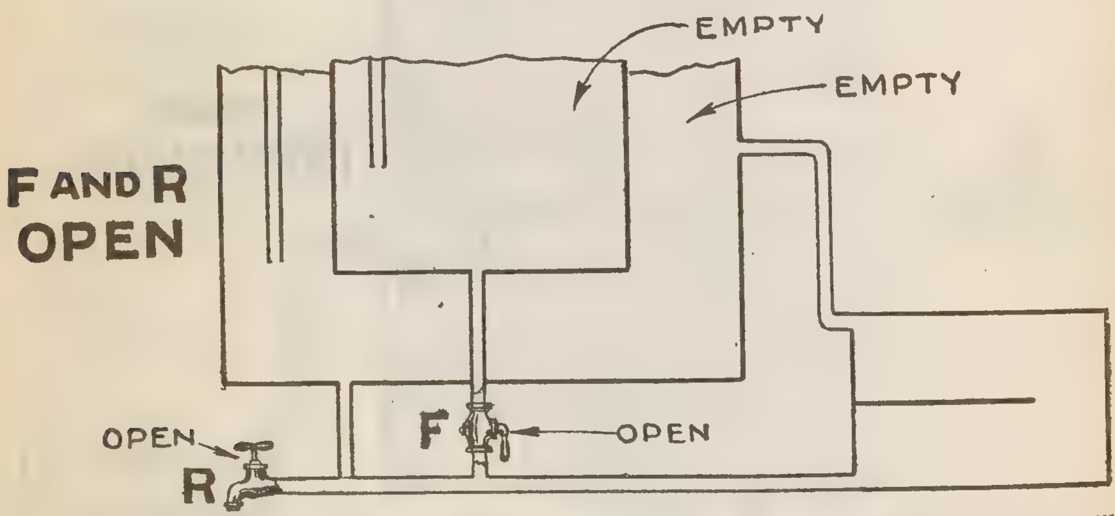


FIG. 6,646.—Operation of double tank system. *6. Drain cocks F and R, open.* Clearly this will drain both tanks and since the outlet to outer tank is in advance of that to inner tank the tendency will be to drain the outer tank faster than the inner tank, as should be, so that there will be no water in outer tank that would tend to callapse inner tank when the latter is empty.

CHAPTER 113

Elements of Sanitation

2. *Drainage*

Drainage is the most important phase of sanitation, and upon the proper installation of the pipes and fixtures comprising the drainage system of any plumbing installation depends the health of the occupants of the house.

A drainage system must take care of the discharge from the fixtures, dispose of the poisonous gases arising from the discharge, and prevent the escape in the house of any of the gases.

To perform this three-fold duty it is composed essentially of:

1. Pipes.
2. Vents.
3. Traps.

Fig. 6,647 illustrates the essential elements of a drainage system, and fig. 6,648 the names of the parts. These two illustrations should be carefully studied and the names of the various parts remembered to avoid confusion in a further consideration of the subject.

Broadly speaking, the drainage system comprises the installation in the house, and the sewer system outside the house, but in this chapter only the house drainage system is presented,

the sewer system outside of the house being taken up in the next chapter on sewage disposal.

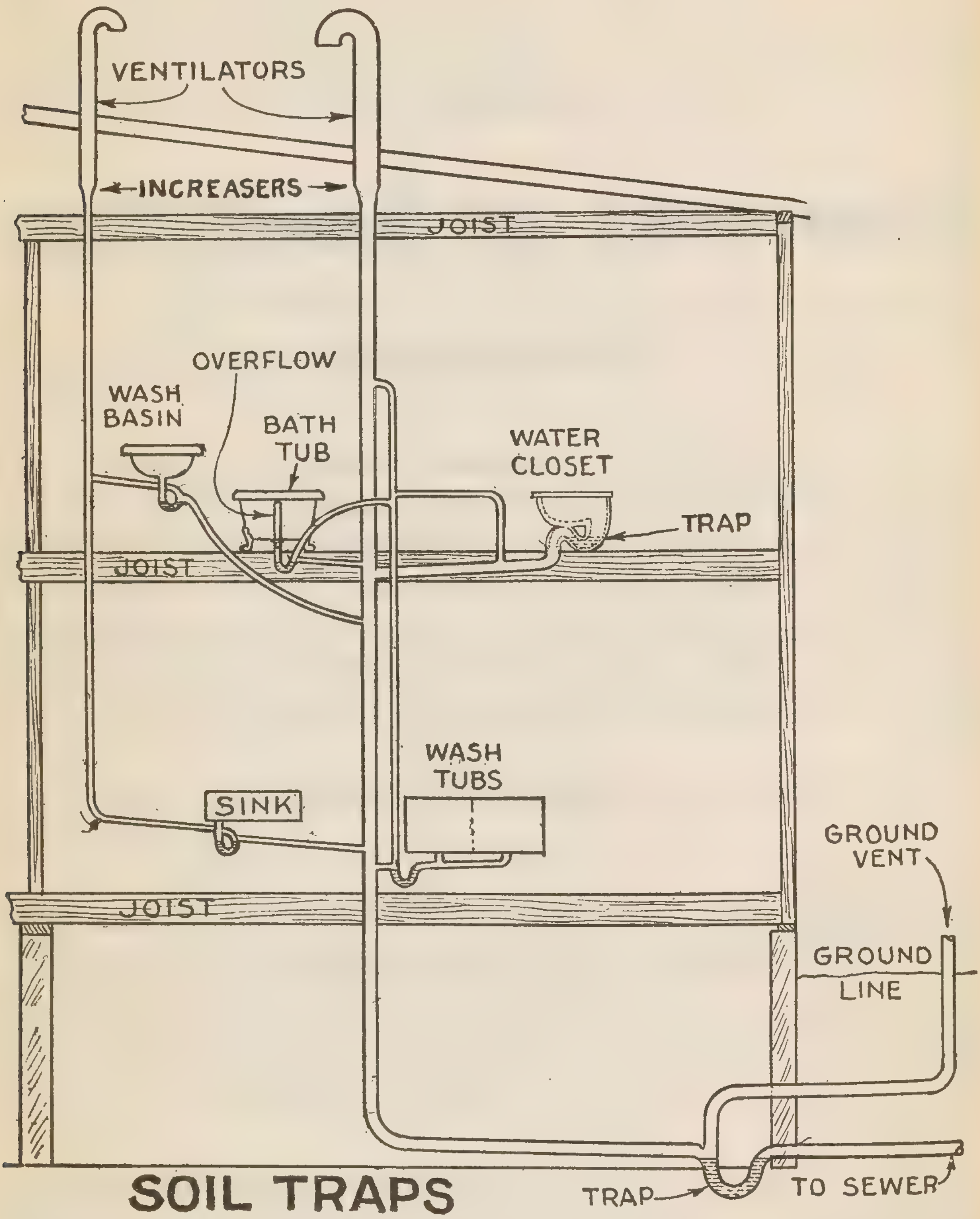


FIG. 6,647.—Typical drainage system showing essential features in the arrangement of the piping and location of traps.

It is very poor economy to try to save a few dollars by installing an inadequate drainage system; some of the fixtures and pipes used may seem unnecessary but they all have their place and should be employed, otherwise the health of the occupants of the house will be endangered.

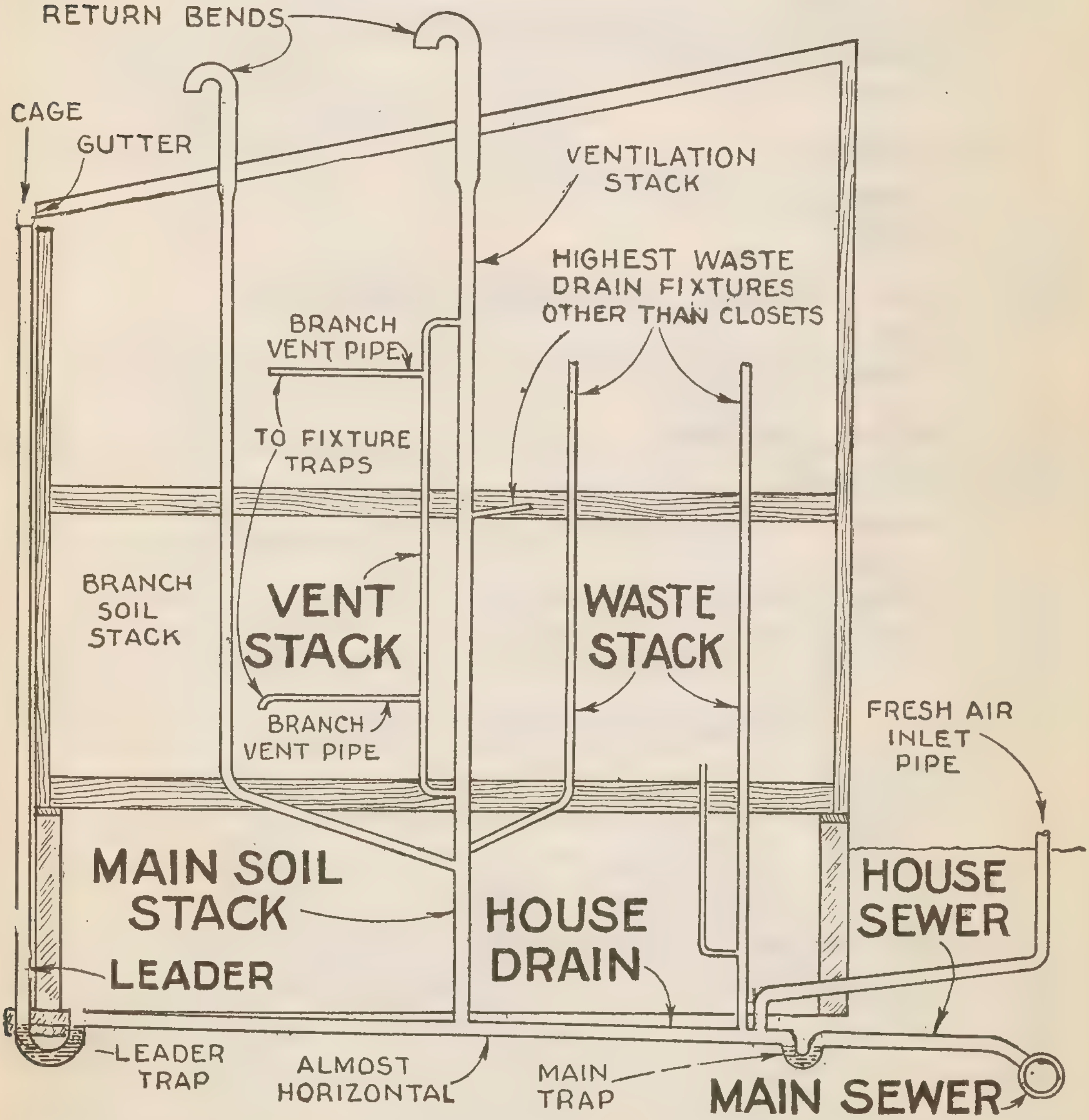


FIG. 6,648.—Piping of drainage system illustrating the names of the various pipes.

Every device that is necessary to dispose of the poisonous gases arising from the sewage passing through the pipes should be employed and every precaution taken to insure the proper working of these devices.

A house drainage system consists essentially of:

1. House sewer.
2. House drain.
   a. Main.
   b. Branch.
3. Soil stacks.
   a. Main.
   b. Branch.
4. Ventilation stack.
   a. Soil.
   b. Waste.
5. Fresh air inlet pipe.
6. Vent stack.
7. Drains.
   a. Leaders.
   b. Area.
   c. Safe.
   d. Sub-soil.
8. Safes.
9. Traps.
   a. Main.
   b. Leader.
   c. Fixture.

An inspection of figs. 6,647 and 6,648 will show the placement and arrangement of the various members comprising the house drainage system. These will now be taken up in detail in the order given.

House Sewer.—This comprises an underground pipe

connecting the house drain at the main trap with the public sewer in the street. The size of the house sewer corresponds to

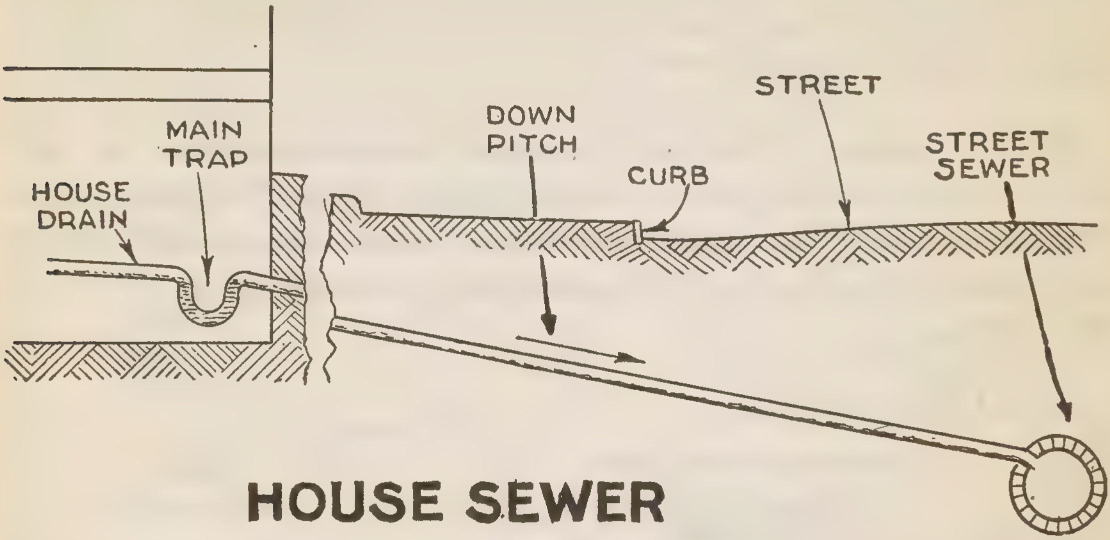


FIG. 6,649.—House sewer or connecting house drain at main trap end with the street sewer and showing its downward pitch to secure proper flow of the sewage into the street sewer.

that of the house drain and it must have sufficient pitch downward to the street sewer to insure proper flow of the sewage into the street sewer as shown in fig. 6,649.

A special form of check valve known as a *back water valve* is sometimes used to prevent the water in street sewers backing up into the house drainage system during heavy rain fall, high tide, etc., as shown in fig. 6,650.

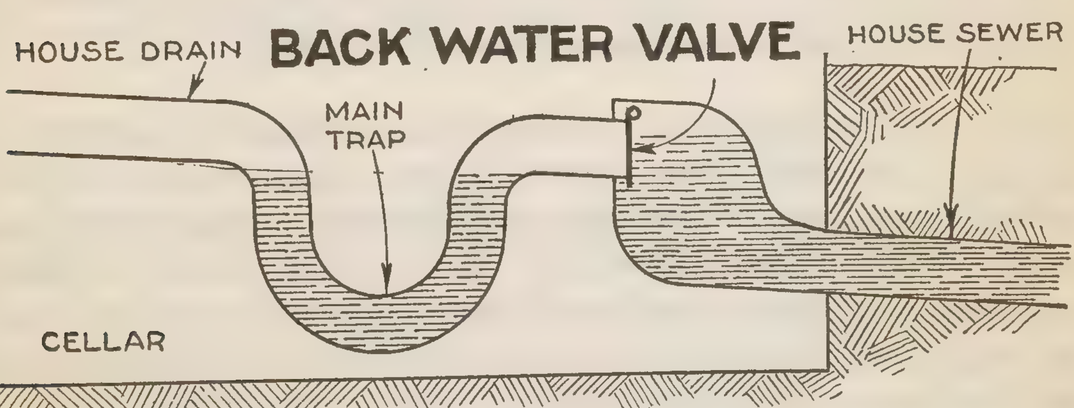


FIG. 6,650.—Back water valve used to prevent back flow of water from street sewer into house drain in time of heavy rain fall or high tide. *This valve should never be used if it can possibly be avoided.*

This valve should never be used unless absolutely necessary since its weight may permit only the liquid to pass to street sewer under normal conditions of the latter, holding back the solids. When used it should be placed in an easily accessible place because the house drain might become choked by its failure to operate.

House Drain.—The large, almost horizontal pipe in the cellar which discharges all the drainage from the house into the house sewer is called the *house drain*. It should pitch downward the same as the house sewer to insure proper flow of the sewage.

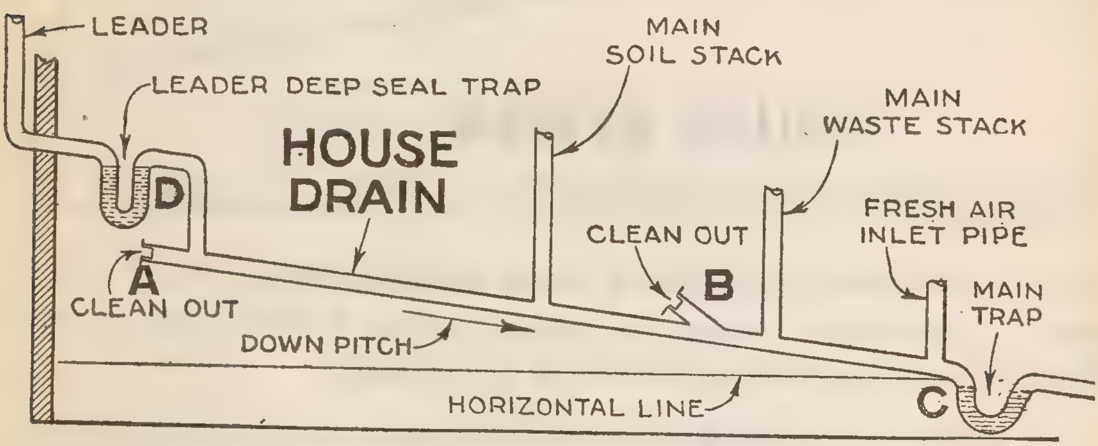


FIG. 6,651.—House drain or line of almost horizontal pipe in the cellar, and which receives the discharge from the various stacks and discharges it into the house sewer. A main trap C, protects the house system from gas from the sewer and the leader trap D, prevents escape of gas in the house system at that point. Two other important provisions are *clean outs* as A and B, and a connection for the fresh air inlet pipe near the main trap as shown.

On small installations one *main* house drain is sufficient, but for large houses one or more *branch* house drains may be necessary because of the scattered locations of the numerous fixtures to be served. Owing to the poisonous nature of sewer gas, this is excluded from the house drain by the main trap, and the drain ventilated by a pipe near the trap opening into the fresh air outside and known as the fresh air inlet pipe.

The house drain with the two safety devices is shown in fig. 6,651.

The illustration also shows the main soil and waste stacks connecting with the drain, also a leader, with leader trap interposed. An important provision for the house drain is a *clean out* or opening accessible by removing a plug, because drains often become clogged and must be cleaned by inserting rods through the clean out opening. The illustration shows two clean outs, one, A, at the end of the pipe and another (formed by means of a Y fitting) at any convenient intermediate point.

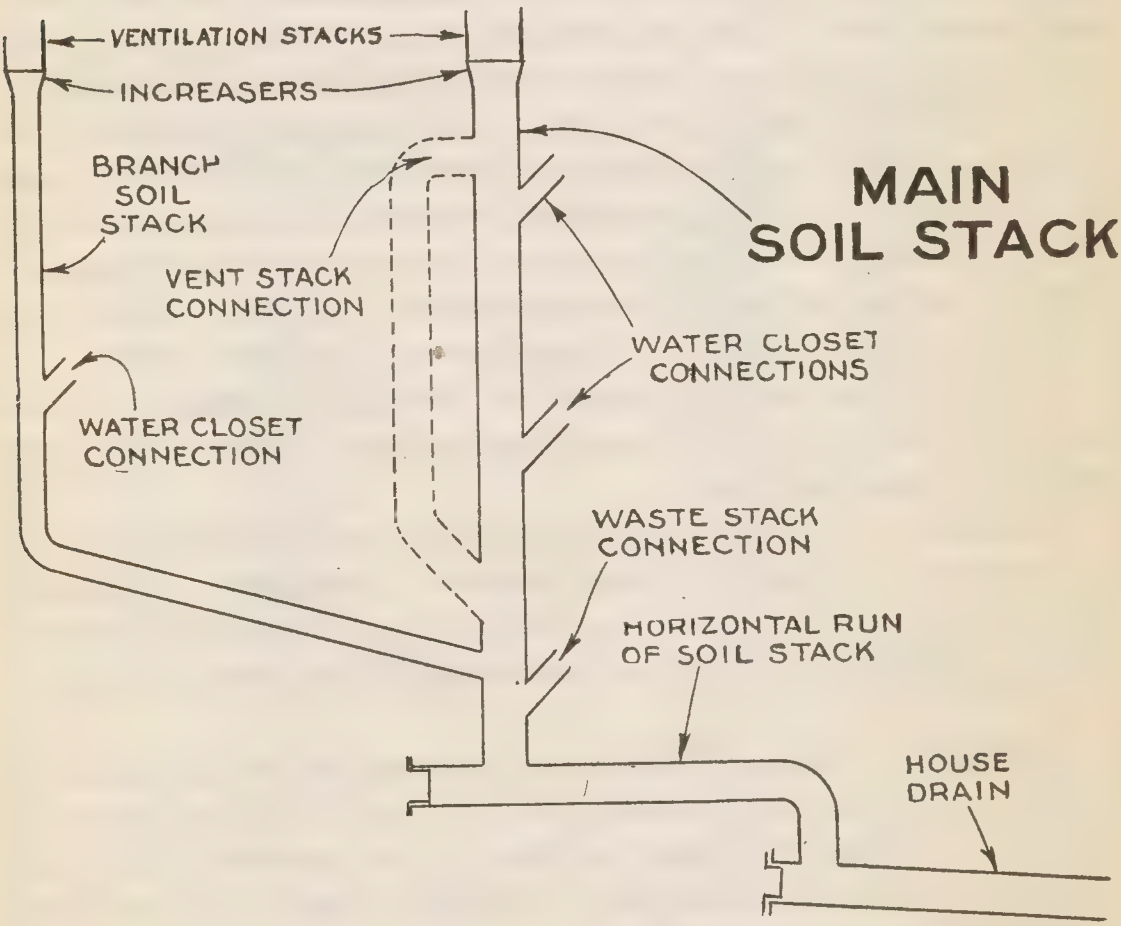


FIG. 6,652.—Main and branch soil stacks and their connections. Avoid horizontal runs if possible, but when they must be installed, provide clean out as shown.

When it is considered that the flow of sewage in a house drain is due to very little pitch (sometimes only ¼ in. per foot), it must be apparent that "stoppage" can easily occur, hence it is quite necessary to provide convenient access to the

interior of the house drain by means of suitably placed cleanouts as shown.

Soil Stack.—The stack which receives the discharge or "soil" from water closets is called the *soil stack*, as distinguished from those which drain the other fixtures, such as bath tub, wash stand, etc. This is a vertical pipe, having its lower end connected to the house drain, open to the atmosphere through the ventilation stack and having connections to receive the soil from water closets at various intermediate points as shown in fig. 6,652. It also sometimes receives the discharge from the other fixtures through a waste stack which may connect with it instead of with the house drains. In some cases both ends of the vent stack are connected with the soil stack.

Offsets in soil stacks should be avoided as much as possible. If horizontal runs be necessary they should be provided with cleanouts as shown.

Connections to soil stacks should be made at acute angles (Y branches) instead of at right angles (T branches). On small jobs a single soil stack suffices, but for a multiplicity of fixtures variously located, branch soil stacks are sometimes necessary.

Ventilation Stack.—This is a continuation of the soil, or waste stack through the roof and although it is usually made the same size as the stack to which it is connected, it is advisable to increase it one size, especially when it is connected to a stack smaller than 4 ins.

The object of the ventilation stack is to give free access to the atmosphere and thus prevent back pressure. Ventilation stacks are increased in size before passing through the roof in order to prevent them becoming choked by frost. Fig. 6,654 illustrates this.

Under no circumstances should a ventilation stack be

extended into a chimney because a back draught would carry the foul air into the house, and also because they are liable to become obstructed by soot or birds' nests.

Fresh Air Inlet Pipe.—On the house side of the main trap there should be connected to the house drain, a pipe leading

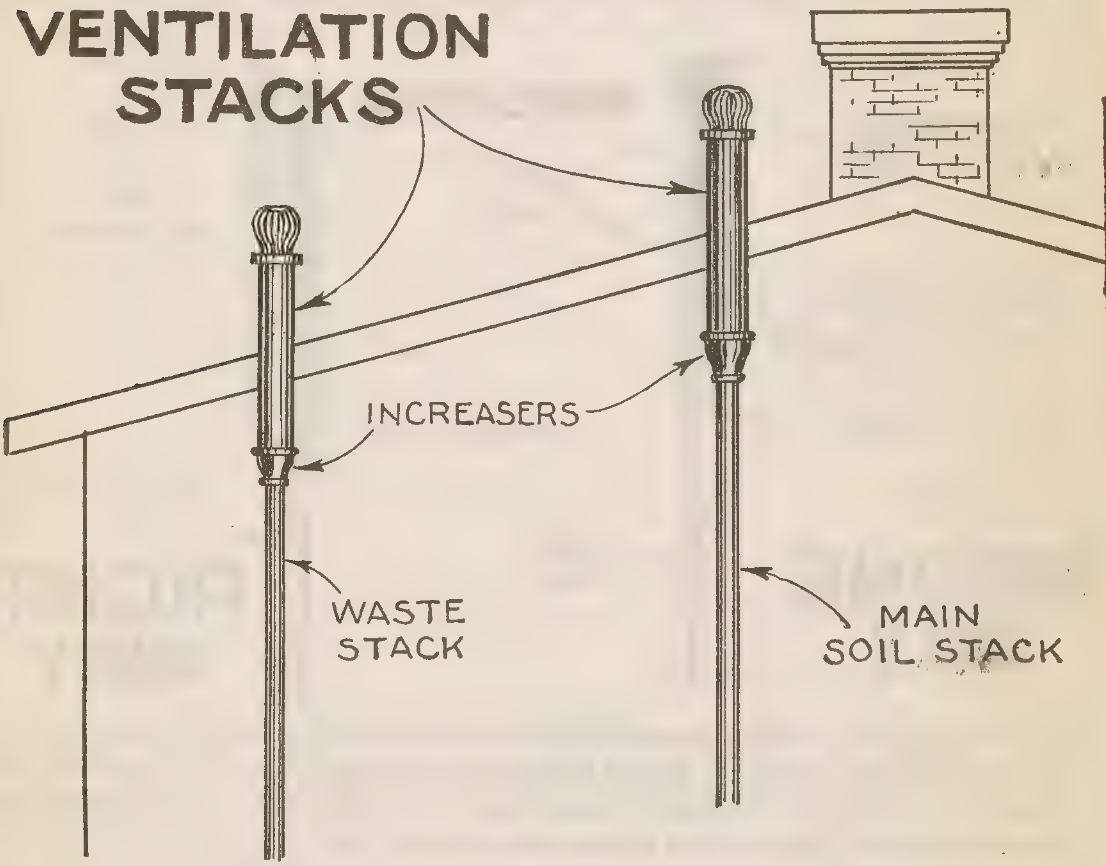
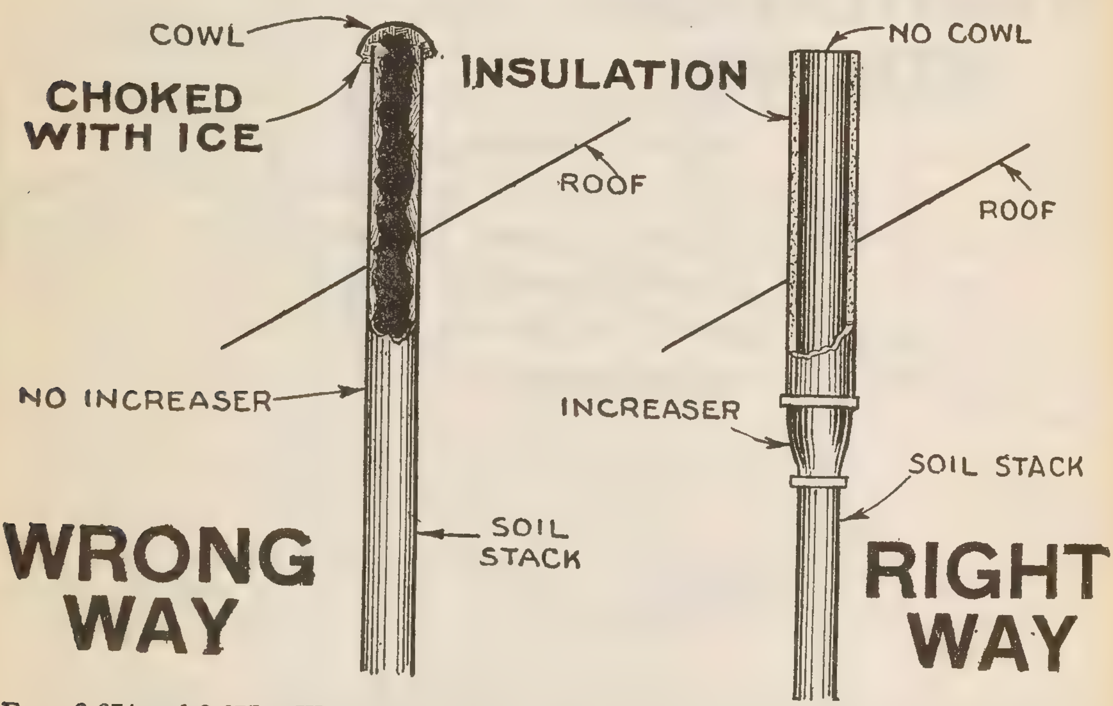


FIG. 6,653.—Soil and waste ventilation stacks being an enlarged continuation of the soil and waste stacks respectively. The tops of such stacks should be left plain and open, not fitted with cowls. When there are trees around the house, the tops should be protected with wire cages. Ventilation pipes should be at least 15 ft. from windows and extend 2 ft. above the roof. Some authorities advise the distance to be not less than 3 ft.

outdoors and having its end open to the atmosphere. This is the fresh air inlet pipe and its object is to supply fresh air to the drainage system and permit a circulation of the fresh air

through the system, driving the gases out of the system through the circulation pipe which projects above the roof. The motive force which produces the circulation is the same in principle to that causing a draught in chimneys, that is, when the air or gases in the drainage system are lighter than an equal volume of the outside atmosphere, air will flow in through the fresh air inlet pipe and drive the gases in the system up



Figs. 6,654 and 6,655.—Wrong and right way to construct ventilation stacks in cold climate. In fig. 6,654 the cowl with its restricted opening and no increase in the size of pipe are two conditions which will probably cause the stack to choke with frost and become useless. Evidently in fig. 6,655 this trouble is avoided by increasing the size of stack and in extreme cases protecting it with some form of insulation as asbestos, hair, felt, etc.

through the soil stack, ventilation stack, and out into the atmosphere above the roof where they will do no harm. The arrangement of the fresh air inlet pipe and the circulation just described are shown in fig. 6,656.

The conditions are usually such as will give the circulation indicated by the arrows which prevents the system becoming fouled with poisonous gases by removing them as generated. Accordingly if a trap lose its

seal by any of the usual causes, only relatively pure air would enter the building due to the scavenging effect of the circulation from the fresh air inlet.

In a properly designed system, there will hardly if ever be any "blowback" or discharge of air through the fresh air inlet, but for protection in case this happen, the fresh air inlet must, according to many of the health department laws, be at least 15 feet from any window or door.

For the free flow of ventilating air the fresh air inlet pipe should be at

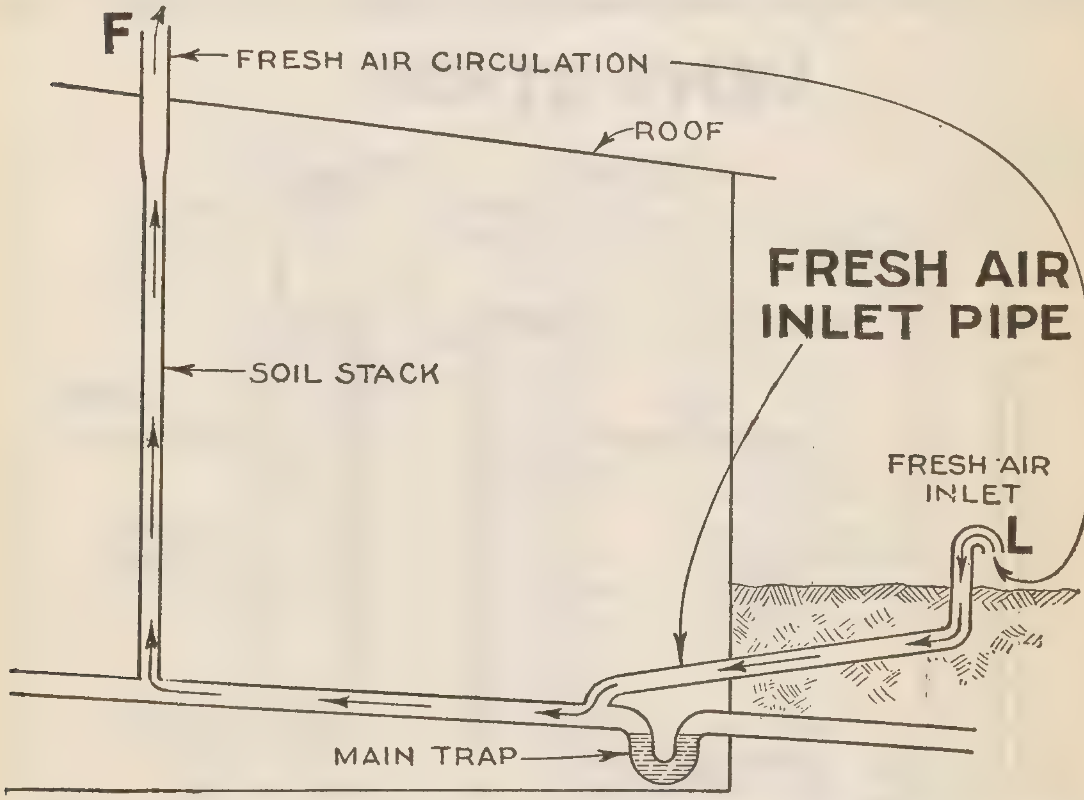


FIG. 6,656.—Fresh air inlet pipe illustrating the circulation of fresh air through the system, entering at **L**, and discharging through ventilation pipe above roof at **F**, as indicated by the arrows.

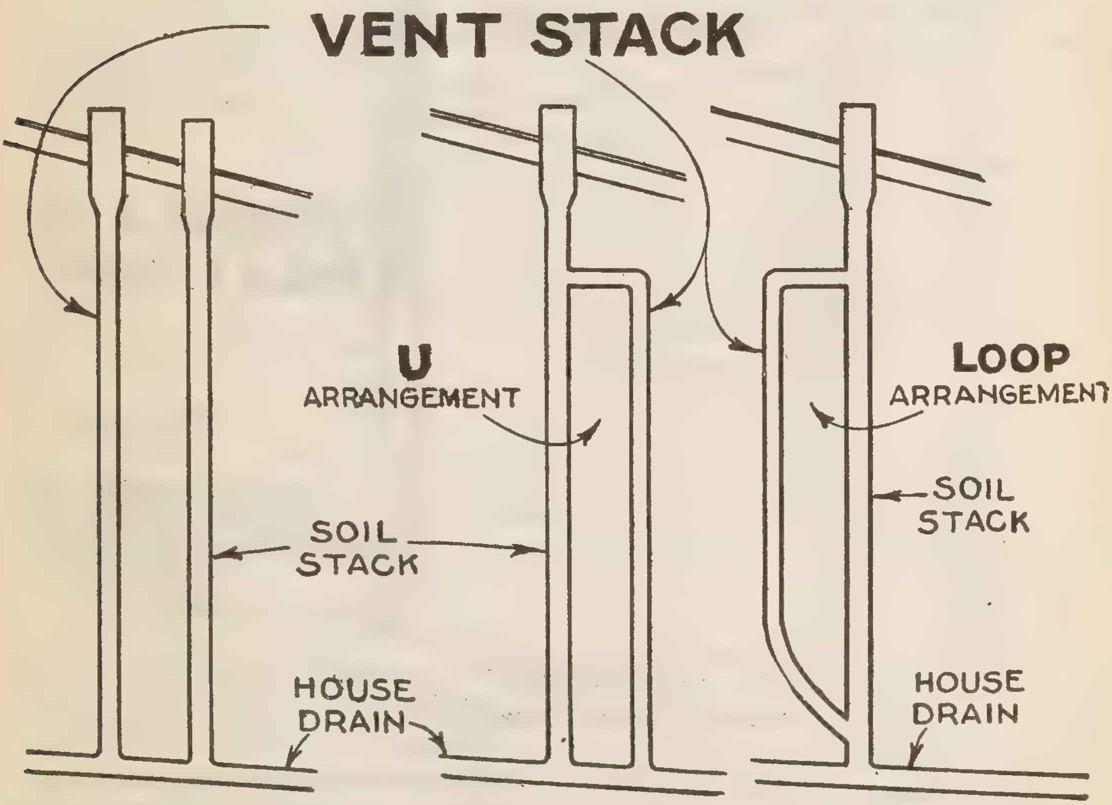
least as large as the house drain and should be free from a multiplicity of elbows. Use easy bends and as few as possible.

The inlet end of the pipe should be protected by a U bend, or equivalent so that the inlet looks down to prevent any obstruction entering the pipe. Evidently the inlet should be at a suitable elevation above the ground so as to preclude snow shutting off the air supply. The length of the fresh air inlet pipe, as later explained, should not be less than the distance

from its junction with the house drain to the stack which it ventilates to avoid back puffs or discharge from the fresh air inlet.

Vent Stacks.—In distinction from a ventilation stack, a vent stack is *a special line of pipe run parallel with the soil and waste stacks into which the branch vent or back air pipes from the fixture traps are connected.*

The object of the vent stack is to supply air to these back



Figs. 6,657 to 6,659.—Various methods of connecting vent stacks. Fig. 6,667, direct to house drain; fig. 6,658, U arrangement or vent stack and house chain connection; fig. 6,659, loop arrangement. The offset leg of loop is frequently used for soil, but this is not the best method.

air pipes so as to prevent loss of seal in traps by syphonage and back pressure.

Figs. 6,657 to 6,659 show several methods of arranging the vent pipe. The various systems of venting as suggested by these arrangements are explained at length later in this chapter.

Drains.—There are numerous drains other than the ones already described and which may be called *clear water drains*, as distinguished from those serving the soil and waste. These clear water drains carry off water from the leaders, area, safes, and subsoil. With exception of the subsoil drain they are protected from the soil and waste drainage gases by traps.

Thus in fig. 6,660 the leader and area drains discharge into

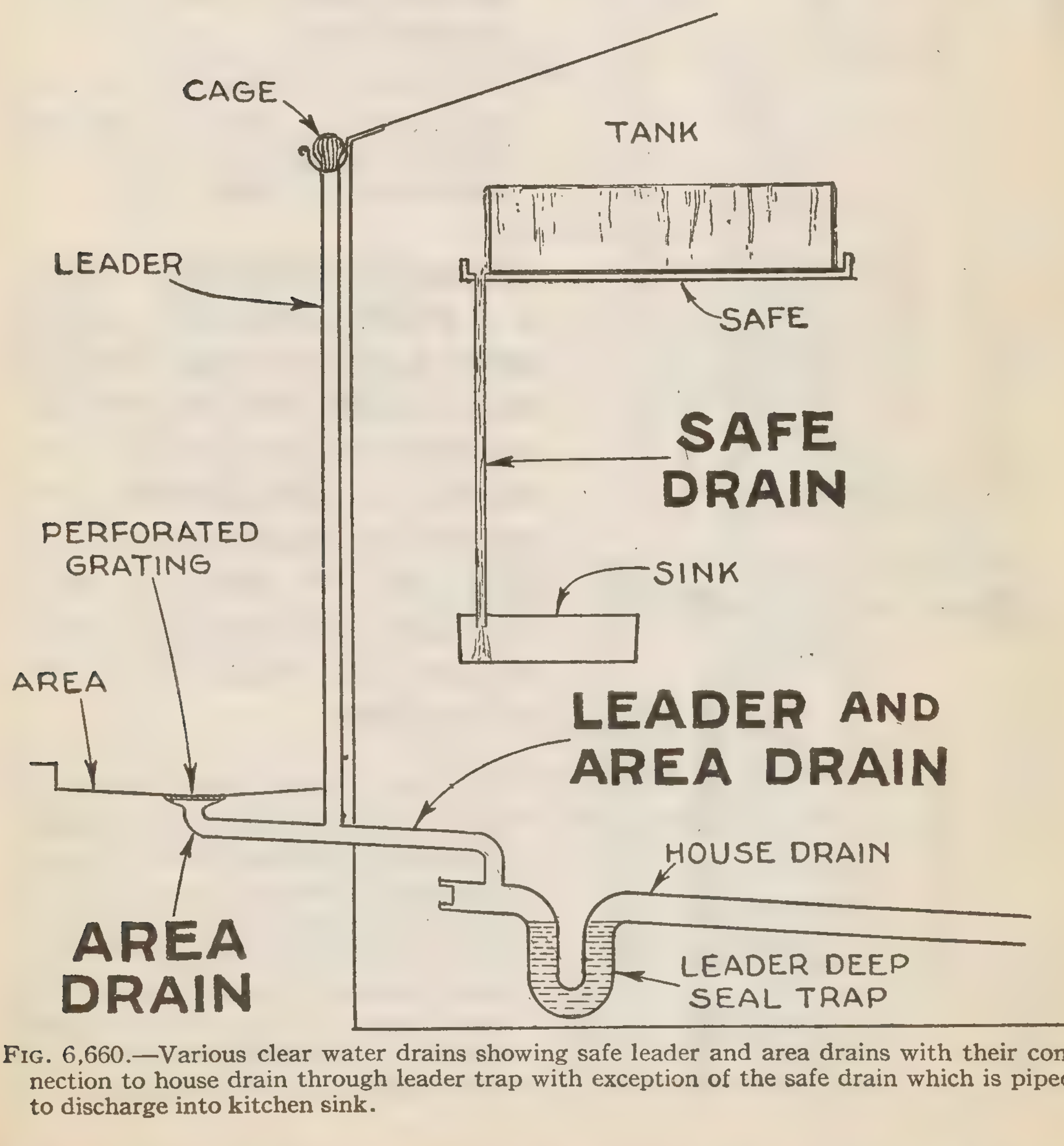
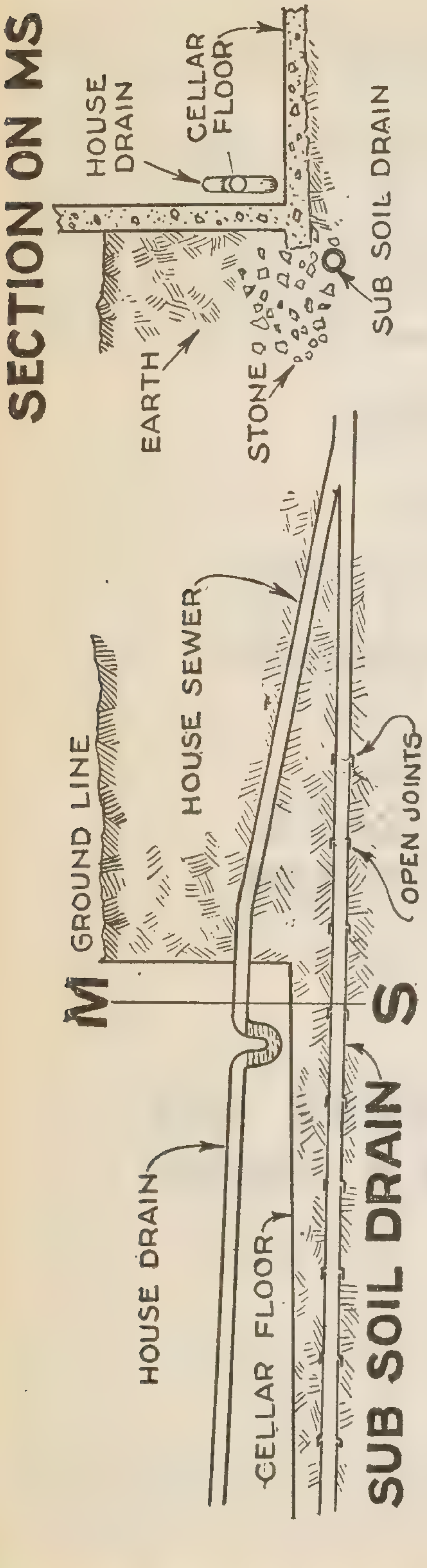


FIG. 6,660.—Various clear water drains showing safe leader and area drains with their connection to house drain through leader trap with exception of the safe drain which is piped to discharge into kitchen sink.



FIGS. 6,661 and 6,662.—Sub-soil drain. Fig. 6,661 side view; fig. 6,662, end sectional view. The illustrations show the open joints through which the drain water enters; the protection of these joints by layer of stone and connection of the drain with the house sewer.

the house drain through the leader trap. In the illustration is seen an attic tank with safe with drain discharging into the kitchen sink.

The sub-soil drain is provided when necessary to protect the cellar from ground water. It usually consists of a line of tile pipe with open joints laid parallel with the foundation wall and below the elevation of the cellar floor.

This drain discharges into the house sewer as shown, a trap not being necessary since the pipe is buried below ground.

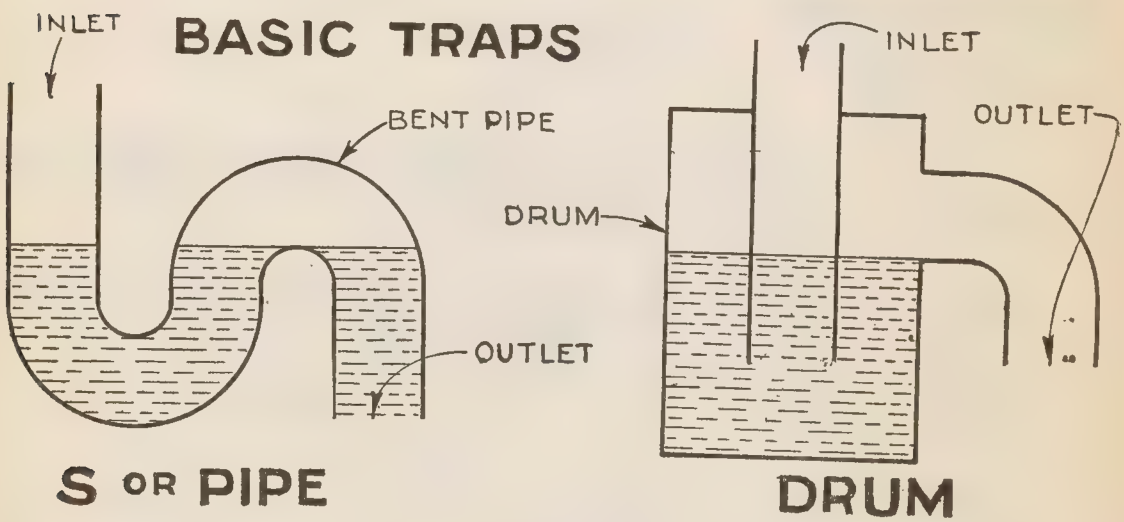
Safes.—By definition, a safe is *a shallow open pan placed under a fixture and provided with a drain pipe to carry off any waste due to abnormal conditions*, as, for instance, the overflow of a tank, sweating of pipes, etc. A tank safe with its discharge (as usually piped) into the kitchen sink is shown in fig. 6,660.

A safe should never discharge directly into the drainage system, but should discharge into any open fixture supplied with water or into leader trap. Safes are not connected directly into the drainage system, even though a local trap be provided, because there is no regular method of supplying the trap seals with water and consequently the

trap seal would in turn be lost due to evaporation, thus allowing sewer gas to enter the building.

In some cases, especially in bath rooms of apartment houses, a safe is provided covering the entire floor of the room. Hence any leakage, splash or overflow from any fixture will be prevented going through the floor to the room below. At least one drain is provided discharging into the open.

Traps.—By far the most important device used in plumbing



FIGS. 6,663 and 6,664.—Basic traps, or the two general forms of which nearly all types of trap are modifications. ***Essentially an S trap*** is simply a piece of pipe bent so as to form a pocket and thus trap a quantity of water as shown in fig. 6,663. A ***drum trap*** consists of a vessel or drum with outlet at top, holding a quantity of water and into which the end of a pipe is submerged as in fig. 6,664.

is the trap. It is defined in general as *a form of check valve which permits the free discharge of waste or soil from the fixtures into the drainage system but prevents the escape of sewer gas.*

The valve is formed by a body of water which is "trapped" by the shape of the device, hence the name *trap*.

There is a multiplicity of traps to meet the various conditions encountered, and in a classification, nearly all of these may be considered as modifications of two fundamental or basic forms as shown in figs. 6,663 and 6,664 and classified as:

1. S traps.
   a. S,
   b. ¾ S.
   c. P or ½ S.
   d. Bag.
   e. Hunchback.
   f. Running or lying.
   g. Flask.
   h. Open wall.

2. Drum traps.
   a. Pot.
   b. Bottle.
   c. Bell.

In the above tabulation the first mentioned class (S traps) are sometimes called *round pipe* or *Du Bois* traps.

Traps may also be classified in various other ways, as:

1. With respect to basic construction, as:
   a. Round pipe.
   b. Drum.

2. With respect to operation, as:
   a. Syphon.
   b. Non-syphon (so called)
   c. Self-scouring $\left\{\begin{array}{l}\text{S traps.}\\\text{centrifugal.}\end{array}\right.$
   d. Centrifugal.
   e. Mechanical seal. $\left\{\begin{array}{l}\text{gravity.}\\\text{buoyancy.}\end{array}\right.$
   f. Deep seal.

3. With respect to service, as:
   a. House.
   b. Grease.
   c. Refrigerator.
   d. Main.
   e. Deep seal, leader, or safe.
   f. Fixture.
   g. Closet, etc.

Operation of S Class Traps.—Fig. 6,665 shows an elementary S trap, one end connected to house drain or other part of the drainage system containing poisonous sewer gas. The U portion of the S bend contains water, being full when at the elevation shown.

Evidently, if the pressure of the sewer gas be the same as the pressure of the pure air, the columns of water in the two legs will be the same

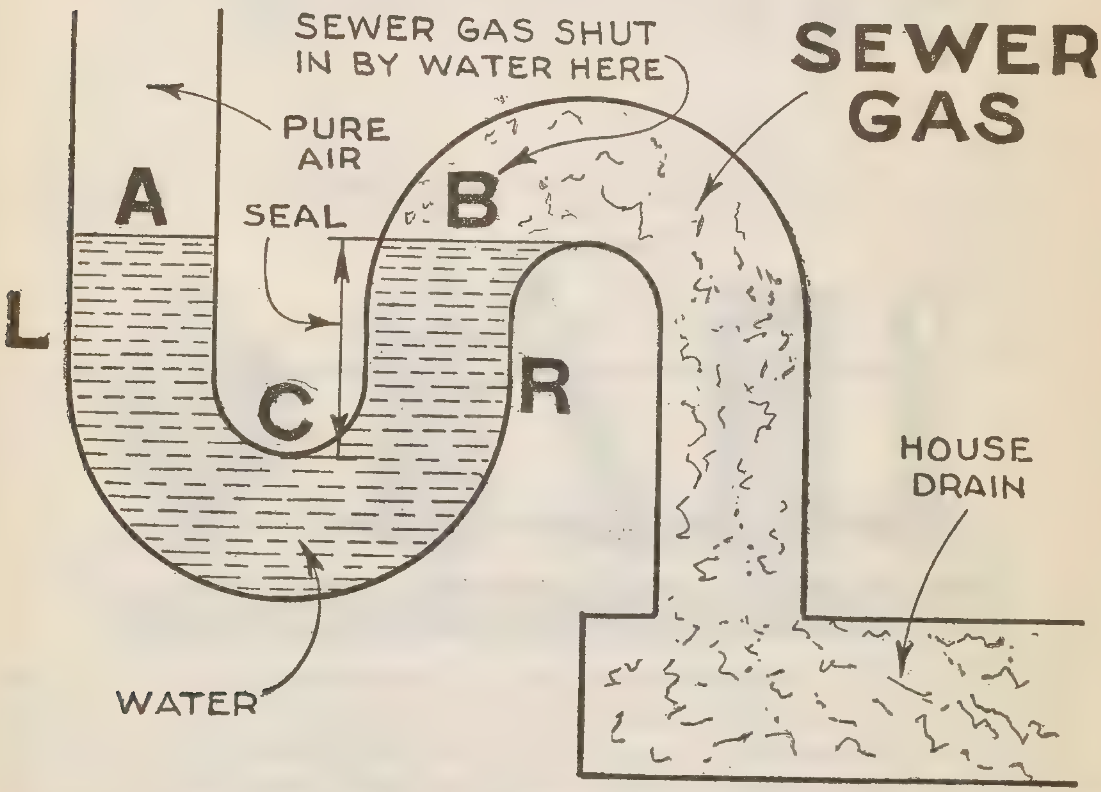
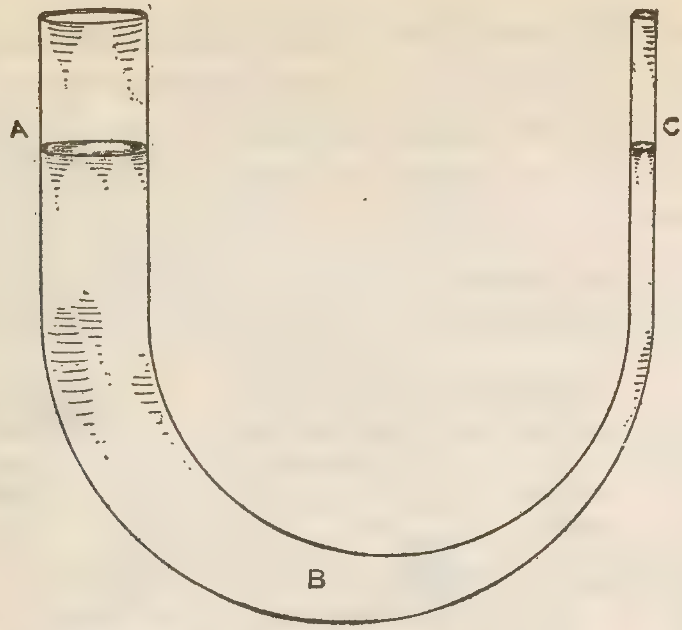
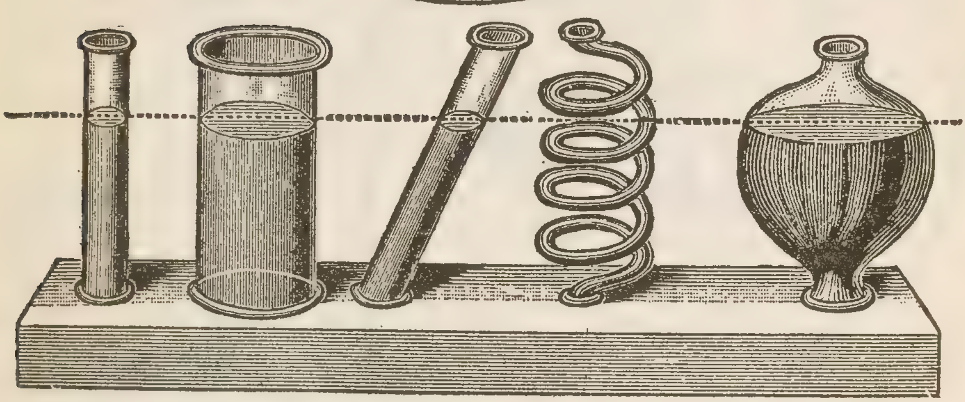


FIG. 6,665.—Operation of S class trap. **1**. Normal condition of trap in shutting off sewer gas; water levels **A** and **B**, the same in legs **L** and **R**, indicating that the sewer gas pressure in leg **R**, is the same as the pure air (atmospheric) pressure in leg **L**, giving maximum *seal* when trap is full of water.

height; that is, surface of the water at A, will be same elevation as that at B.

The surface B, of the water closes the pipe containing the sewer gas, and prevents its escape. Now if there be no provision for the escape of sewer gas, the pressure acting on the water surface B, will increase and displace the water columns so that the height in the two legs, R and L, will be more or less unequal, depending upon the difference in pressure of the sewer gas and of the atmosphere.





FIGS. 6,666 and 6,667.—***Hydraulic principles. 1. Fluids rise to the same level in the opposite arms of a U tube.*** Let A B C, be a recurved tube; if water be poured into one arm of the tube it will rise to the same height in the other arm because the pressure acting upon the lowest part at B, in opposite directions, is proportional to its depth below the surface of the fluid. Therefore, these depths must be equal, that is, the height of the two columns must be equal in order that the fluid at B, may be at rest. Unless this part be at rest, the other parts of the column cannot be at rest. Moreover, since the equilibrium depends on nothing else than the heights of the respective columns, therefore, the opposite columns may differ to any degree in quantity, shape, or inclination to the horizon. Thus, if vessels and tubes vary diversely in shape and capacity, as in fig. 6,667 and be connected with a reservoir, and water be poured into any one of them, it will rise to the same level in all. The reason for this will be further understood from the application of the principle of equal moments, for it will be seen that the velocity of the columns, when in motion, will be as much greater in the smaller than in the larger columns, as the quantity of matter is less; and hence the opposite moments will be constantly equal. Hence, water conveyed in aqueducts or running in natural channels, will rise just as high as its source. Between the place where the water of an aqueduct is delivered and the spring, the ground may rise into hills and descend into valleys, and the pipes which convey the water may follow all the undulations of the country, and the water will run freely, provided no pipe be laid higher than the spring.

Finally with increasing pressure of the sewer gas, when the water surface B, recedes below the turn in the pipe at C, sewer gas will pass around this turn and being lighter than water will rise in the other leg L, and escape as shown in fig. 6,668.

The illustration shows the sewer gas bubbling up through the water in column L, and escaping.

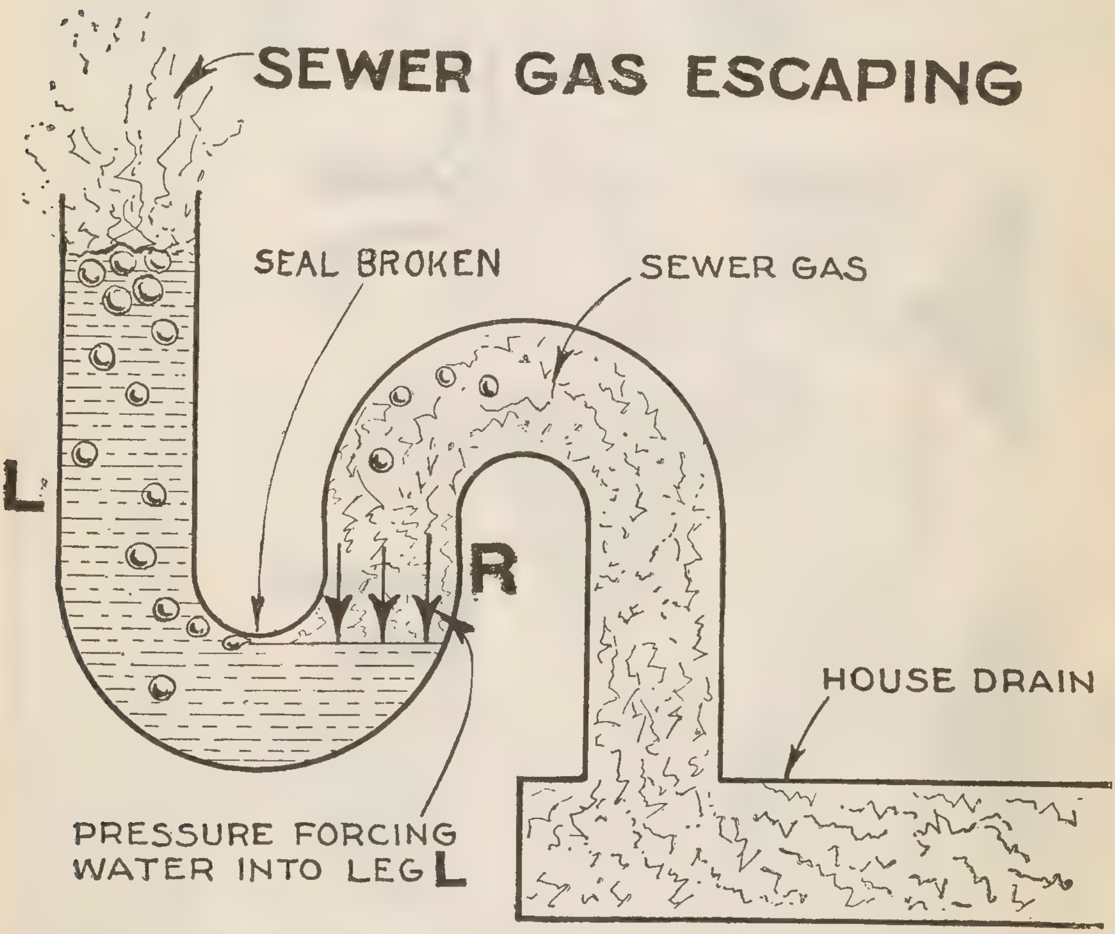
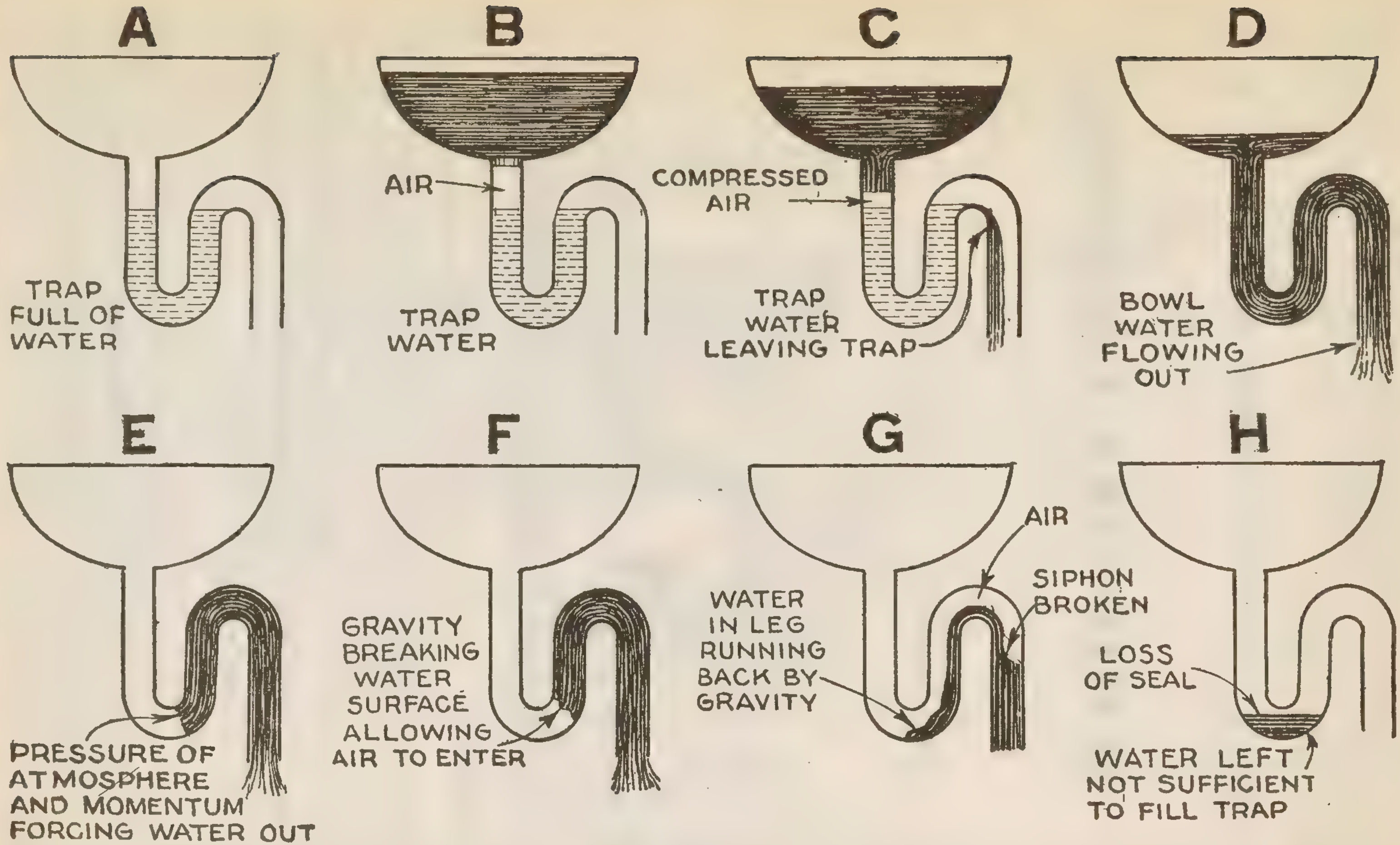


FIG. 6,668.—Operation of S class trap. *2*. Sewer gas escaping due to "loss of seal" caused by excess sewer gas pressure over atmospheric pressure. This condition is possible when the drainage system is not ventilated or the vent is stopped up.

Syphonage.—In order to understand the operation of traps in general, the student should first consider the principle of syphonage. The element of syphonage is a useful one in closet traps but undesirable in fixture traps, and as will be



FIGS. 6,669 to 6,676.—Operation of S class trap, *3:* Effect of syphonage on unvented trap. Fig. **A**, shows normal state of trap full of water with bowl empty; **B**, bowl full of water, showing slug of air in pipe between stopper and trap water; **C**, stopper removed, water beginning to flow by gravity from bowl, slug of air compressed; **D**, bowl water flowing through trap and out; **E**, bowl and one leg of trap empty, water still flowing out of trap due to *momentum* and ***syphonage;*** **F**, water being syphoned out of other leg but end surface breaking and dropping back to bottom of trap by *gravity;* **G**, solid column of water in right leg of trap broken by gravity, allowing air to enter and break syphon; **H**, water remaining in trap after breaking of syphon, usually not enough to retain seal, that is not enough to close pipe to escape of sewer gas.

later shown, provision must be made to prevent syphonage where undesirable.

By definition, a syphon is *a bent pipe or tube with legs of unequal length, used for drawing liquid out of a vessel by causing it to rise within the tube, over the rim or top.*

The shorter leg is inserted in the vessel and the air exhausted from the longer leg, when the pressure of the atmosphere causes the liquid to fill

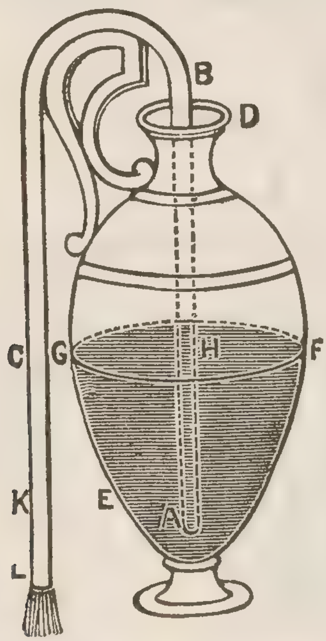


Fig. 6,677.—The *syphon*. Let A B C, be a bent syphon, or tube, of which the leg A B, is plunged into a vessel D E, containing water. If the surface of the water be F G, the leg of the syphon, A B, will be filled with water as high as the surface, that is, up to H, the portion H B C, remaining full of air. If, then the air be drawn off by suction through the aperture C, the liquid also will follow. And if the aperture C, be level with the surface of the water, the syphon, though full, will not discharge the water, but will remain full: so that, although it is contrary to nature for water to rise, it has risen so as to fill the tube A B C, and the water will remain in equilibrium, like the beams of a balance, the portion H B, being raised up high, and the portion B C, suspended. But if the outer mouth of the syphon be lower than the surface F G, as at K, the water flows out, for the liquid in K B, being heavier, overpowers and draws the liquid B H toward it. The discharge, however, continues only until the surface of the water is on a level with the mouth K, when, for the same reason as before, the efflux ceases. But if the outer mouth of the tube be lower than K, as at L, the discharge continues until the surface of the water reaches the mouth A.

the tube and run out of the lower end. This flow depends upon the difference in vertical height of the two columns of liquid, measured downwards from the bend, and ceases when they become of equal height or when the level in the vessel has fallen to the bottom of the shorter leg.

The operation of a syphon, known as *syphonage*, is shown in fig. 6,677, and the effect of syphonage in breaking the seal in figs. 6,669 to 6,676.

From the explanation of syphonage is seen the necessity of providing means of overcoming its tendency to empty the trap whenever water is discharged from its fixture.

Operation of Drum Class Traps.—Fig. 6,678 shows an ele-

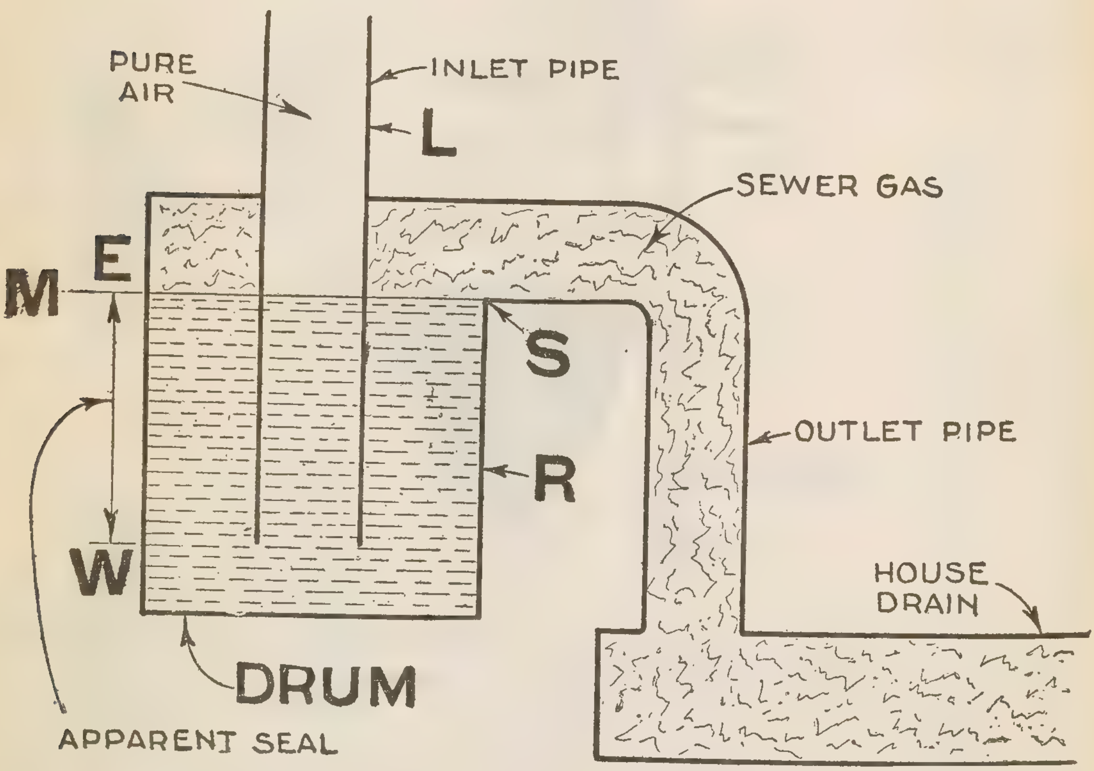
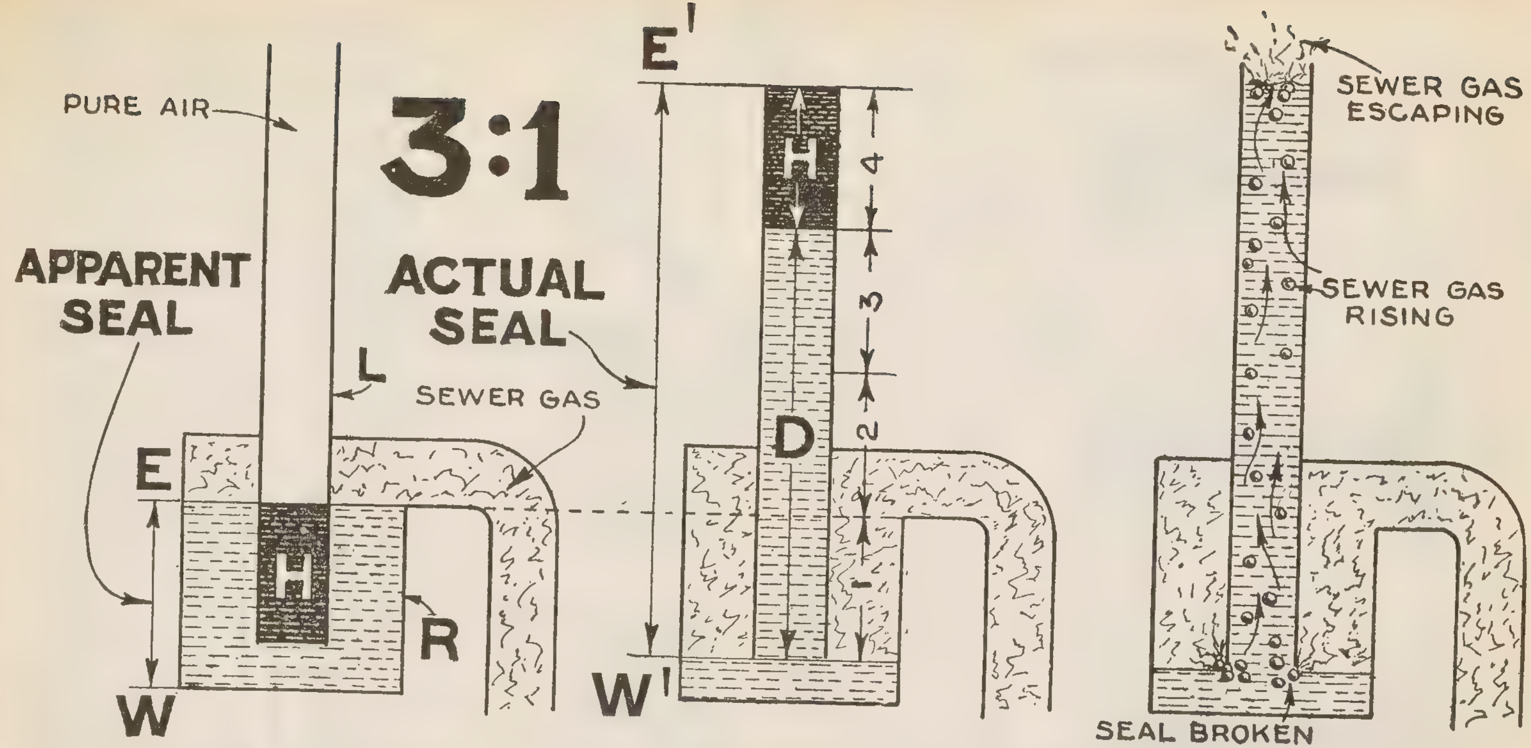


FIG. 6,678.—Operation of drum class trap 1: Normal condition of trap in shutting off sewer gas; the water is at the same level **MS**, in the two legs **L** and **R**, indicating that the sewer gas pressure in leg **R**, is the same as the pure air (atmospheric) pressure in leg **L**. The distance **EW**, that the inlet pipe is submerged is no indication of the actual seal of this class trap as explained in the text.

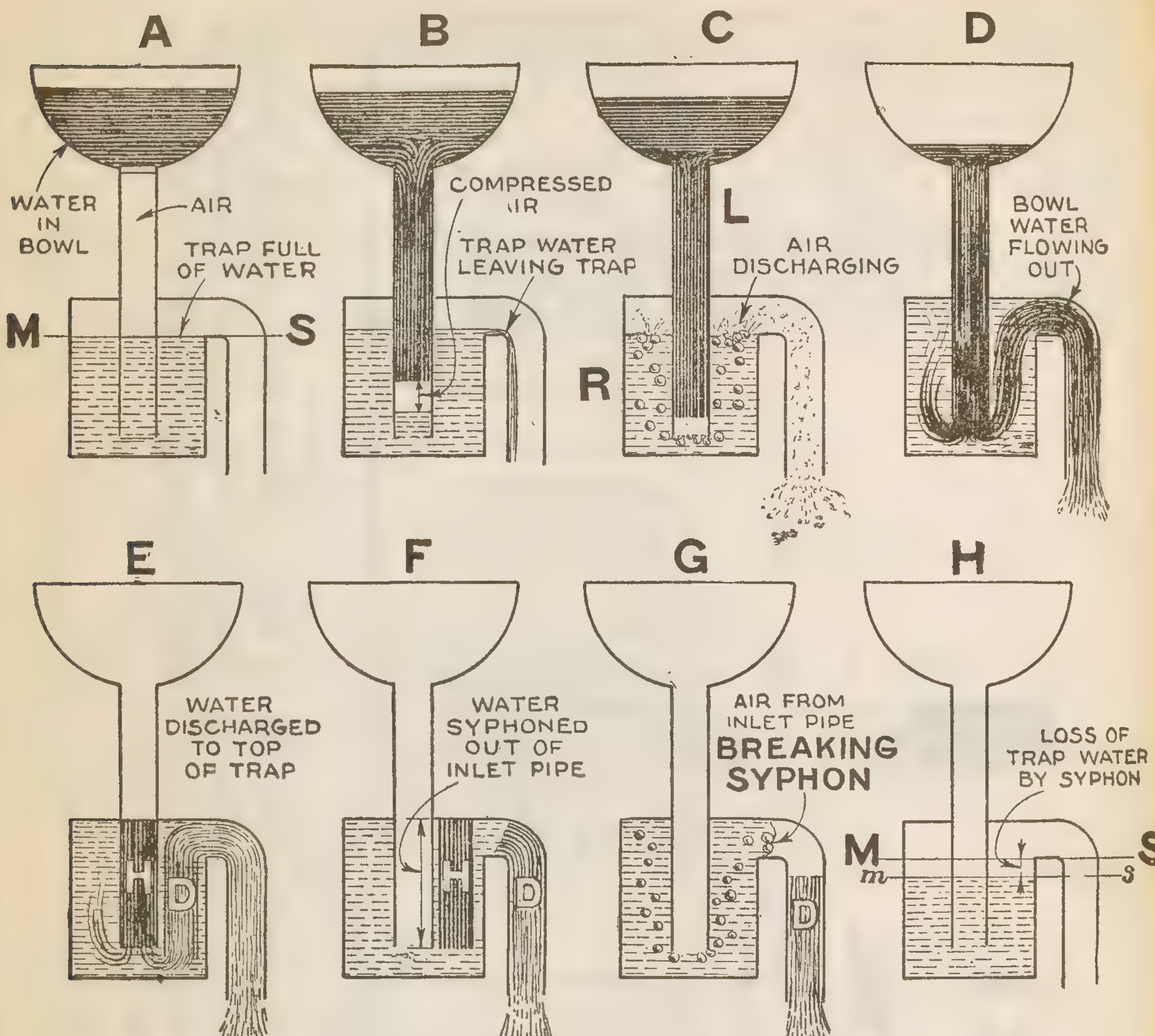
mentary drum trap, one end connected to house drain or other part of the drainage system containing poisonous sewer gas. The inlet pipe projects through the top of the drum, terminating near the bottom. Normally the drum and inlet pipe



FIGS. 6,679 to 6,681.—Operation of drum class trap, *2:* Figs. 6,679 and 6,680 show *apparent* and *actual* seal for a 3 to 1 proportioned trap; fig. 6,681 loss of seal by back pressure.

contain water up to the level, M S, of the outlet pipe. Thus the inlet pipe is shut off from the outlet pipe by the water in the drum or "trap water" preventing the escape of sewer gas. An important inherent feature of the drum is the effectiveness of its seal compared with that of the S trap.

In fig. 6,678, the depth of water EW, or what is ordinarily termed the seal is, strictly speaking,



FIGS. 6,682 to 6,689.—Operation of drum class trap, *3:* Effect of syphonage on unvented trap. Fig. **A**, shows normal state of trap full of water, and bowl full before removing stopper; note air in inlet pipe between stopper and trap water level MS; **B**, stopper removed, water beginning to flow by gravity from bowl, compressing the air and forcing down trap water in inlet pipe; **C**, compressed air discharging from leg L, through leg R and out; **D**, bowl water flowing through trap and out; **E**, bowl and inlet pipe empty to top of trap; **F**, the volume of water H (fig. E), is here shown (fig. F) syphoned from inlet pipe and represented by H, in the drum; the water H, having displaced a similar volume D, from the trap; **G**, the suction produced by the water discharging through the outlet pipe causes air to enter through pipe and break the seal; **H**, water remaining in trap after breaking of syphon; note the trap water has receded from its original level M,S, to *m,s*, corresponding to the loss D (fig. **G**), due to syphonage.

only the *apparent* seal. True, if the water were evaporated out of the drum, the seal would be broken when the water level reached level W; however, owing to the comparatively large volume of water in the drum, it will take longer to evaporate a depth EW, sufficiently to break the seal, than the same depth in an S trap having same size inlet.

Accordingly the depth EW, of water in a drum trap, is no index of the actual seal and is therefore properly called the ***apparent seal*** as distinguished from the ***actual seal***.

Considering further the seal of the drum trap, suppose the trap to be so proportioned that the volume D, of water in the annular space R, to bottom of inlet pipe be, say 3 times the volume H, of water in the leg L, as shown in fig. 6,679. Here the water level is the same in both legs L and R, which condition obtains when the pressure of the sewer gas is the same as that of the atmosphere.

Now, with increasing pressure of the sewer gas the water will be forced down in R, and up in L. The water will rise in leg L, until the water level in R, recedes to the end of the inlet pipe or level W, when the height of the column of water E′W′ (fig. 6,680), in the inlet pipe will be four times the original height EW (fig. 6,679). Accordingly it is seen that under conditions of back pressure, the *actual seal* E′,W′ is four times the *apparent seal* EW.

Further, considering loss of seal by evaporation, there is nearly twice the amount of water to be evaporated in the drum trap (fig. 6,679) as in the S trap with same size inlet fig. 6,665.

It should be noted that the considerable head E′W′, of actual seal in fig. 6,680, will correspond to a safe margin of back pressure over that which would occur in any properly installed drainage system.

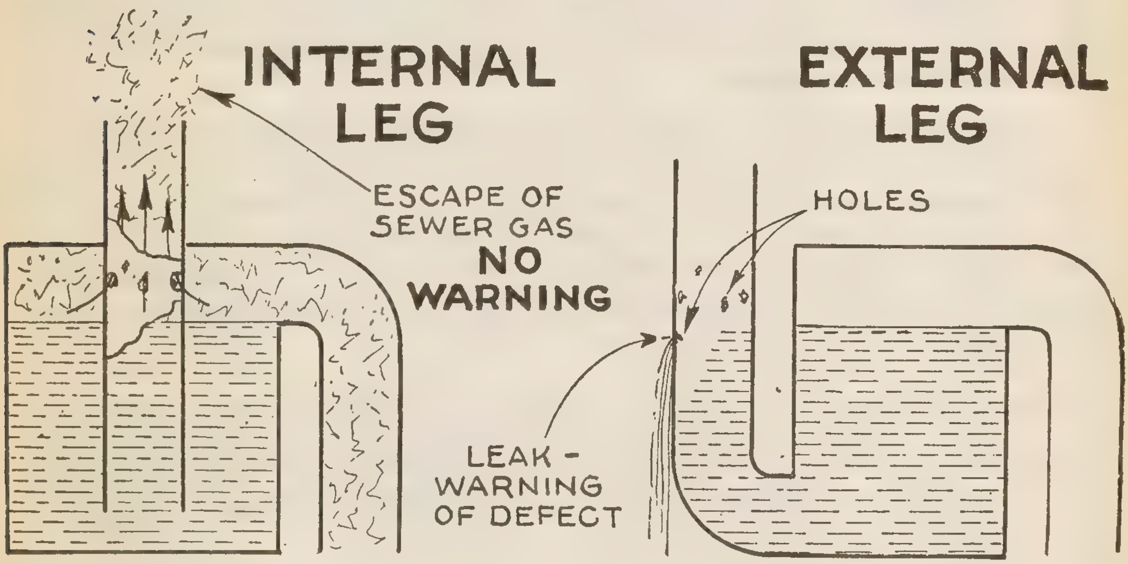
If the pressure should increase more than shown in fig. 6,680, the water in the leg R will be forced down lower than the end of the inlet pipe, and sewer gas will enter the inlet pipe and escape, breaking the seal as shown in fig. 6,681.

It must be clear that an inherent feature of the drum trap is that in construction the diameter of leg R, may be made as many times larger than that of leg L, giving an actual seal as deep as desired.

The operation of an unvented drum trap is shown progressively in figs. 6,682 to 6,689. Studying the action of this

class of trap as here illustrated, it will be noted that there is very little loss of trap water by syphonage during fixture discharge and that it is practically impossible to syphon enough water to cause loss of seal.

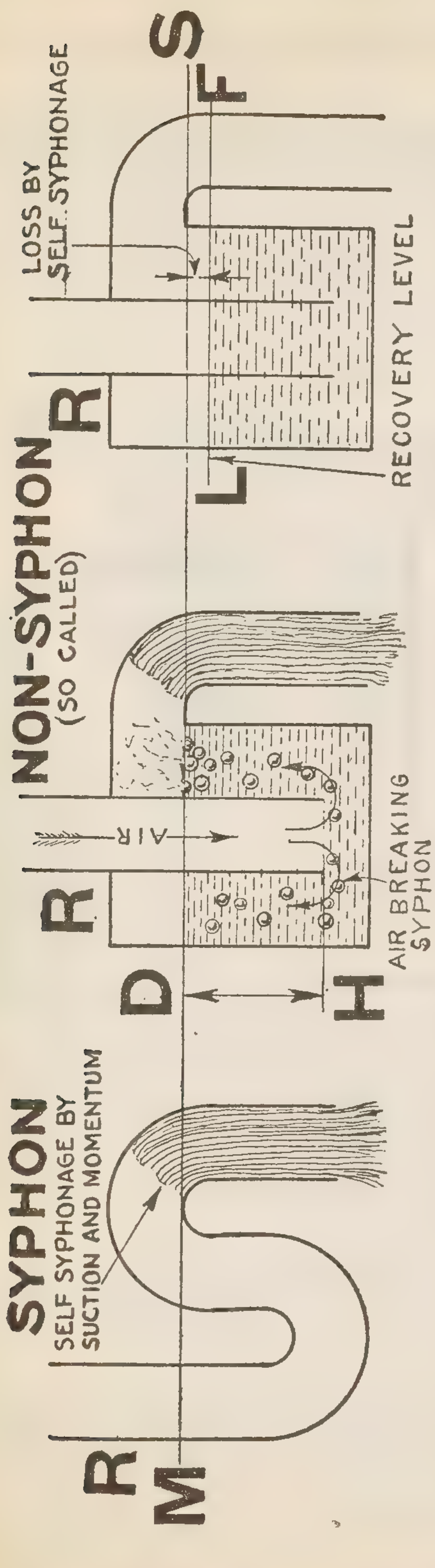
A disadvantage of this form of drum trap just considered is that it has an internal leg or partition, the condition of which cannot be determined, and evidently if a hole be worn or corroded through the internal leg, it would form a passage for the escape of sewer gas without means of detection, as shown in fig. 6,690. To overcome this, the leg is put on the



FIGS. 6,690 and 6,691.—Internal and external leg drum traps. ***In case of defect,*** there is no warning of escape of sewer gas with internal leg, whereas any defect in an external leg is announced by leakage.

outside as in fig. 6,691. In this case, if a hole be worn in the leg, it would become known by leakage.

Operation of Syphon and Non-Syphon Traps.—Traps which are liable to lose their seal by self-syphonage are those of the S class; these are sometimes called syphon traps in distinction from the so-called non-syphon traps or those of the drum class which cannot lose enough water to destroy the seal by self-syphonage. Here, it should be noted, that the



FIGS. 6,692 to 6,694.—Comparison of syphon and non-syphon traps. The effect of *self-syphonage* on an S, or syphon trap is, to suck practically all the water discharged from the fixture into the waste pipe leaving sometimes not enough water in the trap to produce a seal; the effect is augmented by the *momentum* of the discharge current moving at considerable speed. In the discharge of a non-syphon trap, as soon as the water is out of the inlet leg R (fig. 6,692), that is, emptied to level H, the suction will draw in air which breaks the syphon. Assuming, that due to gradual breaking of the syphon and momentum, all the water above normal level M,S, is drawn out into the waste pipe, part of the water remaining in the drum will flow back into leg R, as shown in fig. 6,693, until the water level in R, is the same as in the drum, and this evidently will be at same elevation L,F, lower than the normal level M,S. This lowering of level, being due to the volume of water taken from the drum to fill leg R, or equalize the levels in R, and drum. The fall in level from M,S, to L,F, being the loss due to self-syphonage. This being very small as compared with the S trap, the drum trap is called a non-syphon trap.

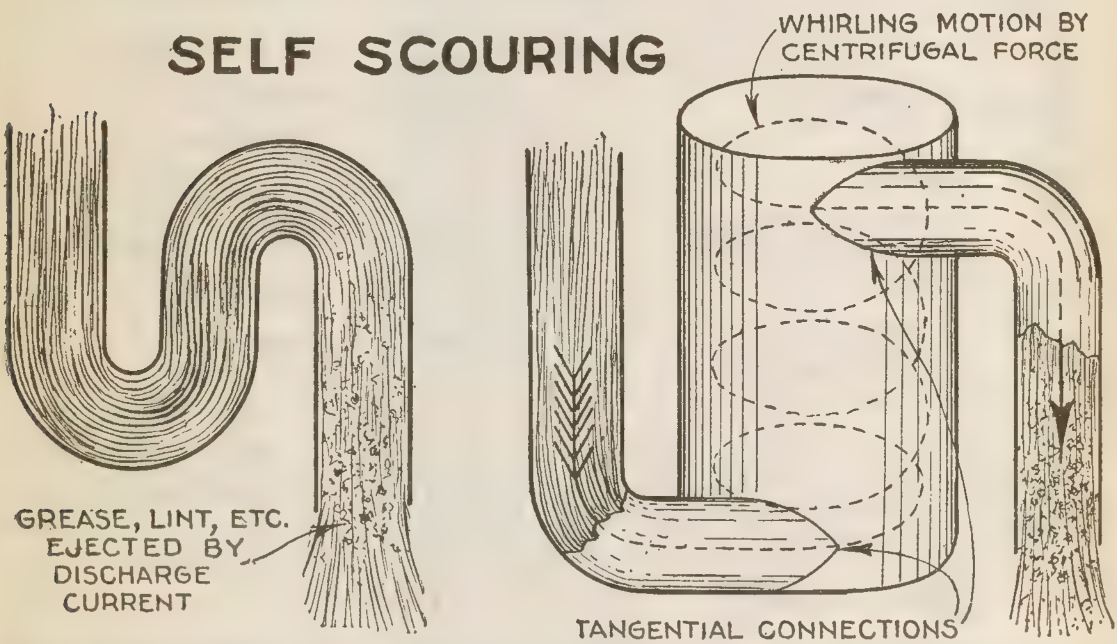
term self-syphonage means the *direct action of the water discharging from a fixture in syphoning practically all the water discharged from the fixture, leaving not enough in the trap to form a seal.* This is in distinction from syphonage due to other causes.

The operation of syphon and so-called non-syphon traps is shown in figs. 6,692 to 6,694.

Operation of Self-Scouring Traps.—An important feature desirable in a trap is that it shall be self-cleaning, otherwise it would soon become fouled with adhering grease, lint and

other foreign matter which would interfere with its proper working.

To prevent lodgement of foreign matter, the construction of the trap should be such that the discharge current will sweep over the entire internal surface of the trap, as in the S trap, or the centrifugal type (tangentially connected) drum trap as shown in figs. 6,695 and 6,696.



FIGS. 6,695 and 6,696.—Self-scouring principle in traps: *The discharge water should sweep over the entire internal surface*. In fig. 6,695, the S trap, fulfills this condition by directing the flow through a bent pipe of constant cross section producing the maximum scouring effect. The drum trap, fig. 6,696, is rendered self-scouring by connecting the inlet and outlet pipes tangentially, introducing centrifugal force which causes the current to flow with whirling motion sweeping the interior surface of the drum as it ascends to the outlet.

Operation of Mechanical Traps.—Typical mechanical traps are those provided with a ball to form an additional or mechanical seal for the trap.

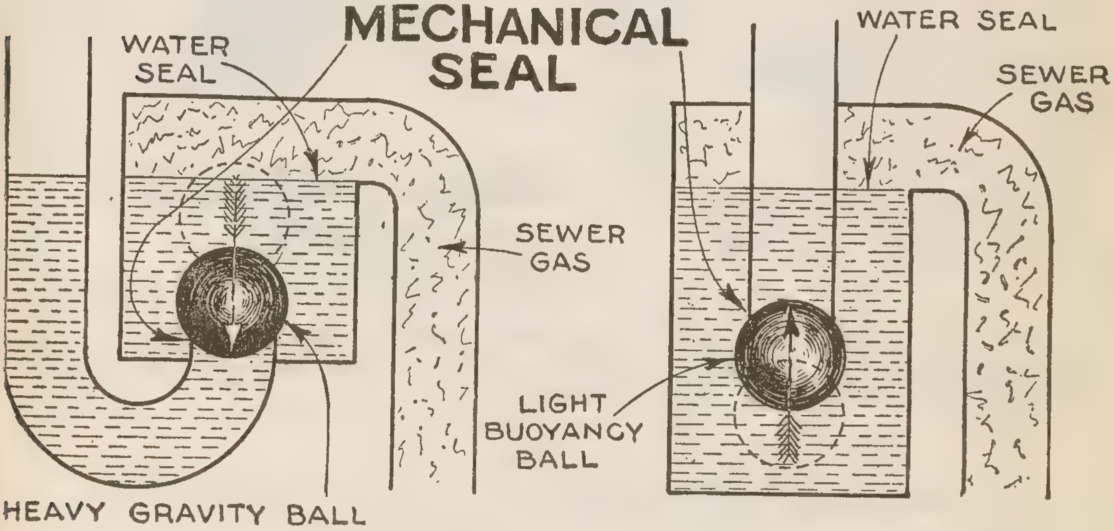
The ball in some is *heavier* than the water, and in others, *lighter*, giving two classes of mechanical trap which may be called:

1. Gravity.
2. Buoyancy.

as shown in figs. 6,697 and 6,698.

The gravity class as seen has *a ball **heavier** than water*, so that it tends to sink.

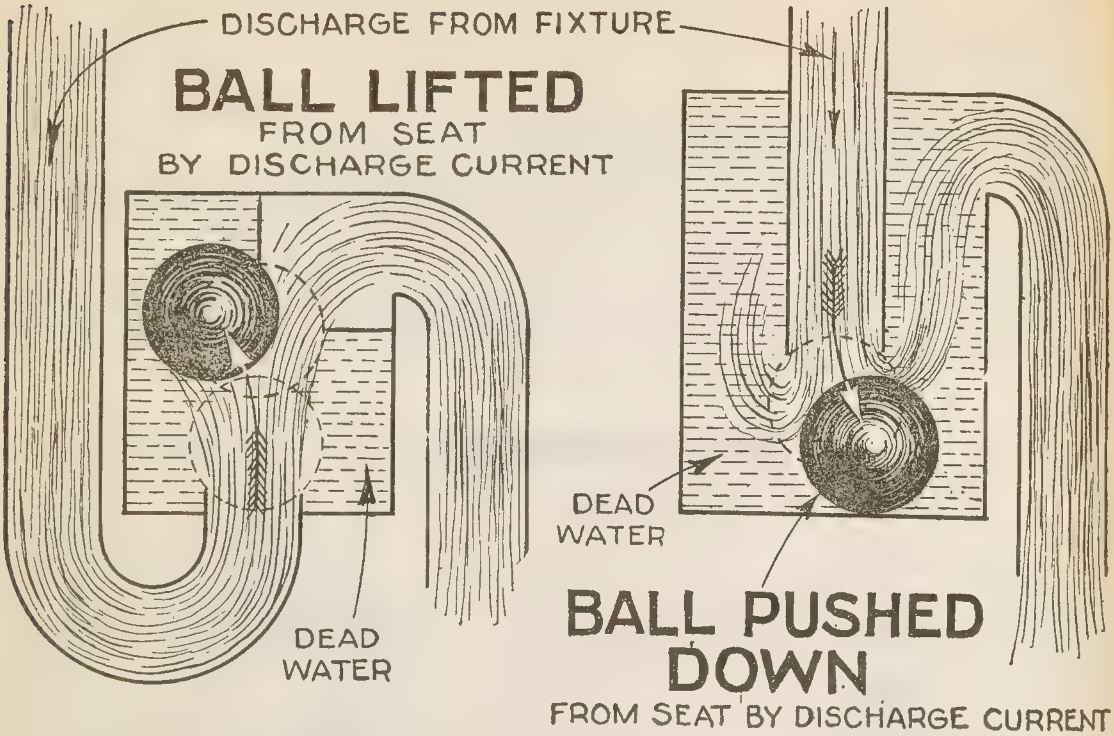
The inlet entering through the bottom and the outlet at the side. After each discharge of the fixture the ball falls to its seat on the opening formed by the inlet at the bottom.



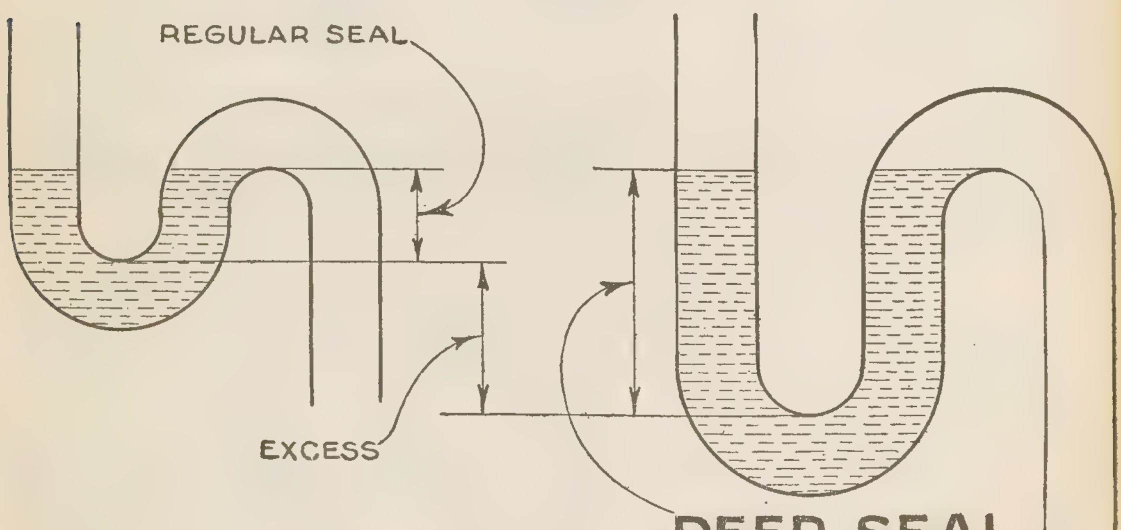
FIGS. 6,697 and 6,698.—Gravity and buoyancy types of mechanical trap. When no discharge is taking place, the gravity ball (fig. 6,697) being *heavier* than water sinks by gravity and seats itself over the inlet opening; similarly the buoyancy ball (fig. 6,698) being *lighter* than water rises and seats itself under the inlet opening, thus, in both cases, forming a mechanical seal which renders the trap more resistive to loss of seal by syphonage or evaporation.

This trap is intended to be effective against syhponage by means of the ball covering the outlet when a partial vacuum is formed in the waste pipe, and to be effective against back pressure by the ball covering the inlet to the trap.

The buoyancy class has *a ball **lighter** than water*, so that it tends to float. It is so constructed that the ball rises and covers the inlet of the trap after each discharge. Mechanical traps, although they give a very effective seal under abnormal pressure conditions, cannot be depended upon, because they are not self-scouring, resulting in the accumulation of filth, which soon destroys the mechanical seal.



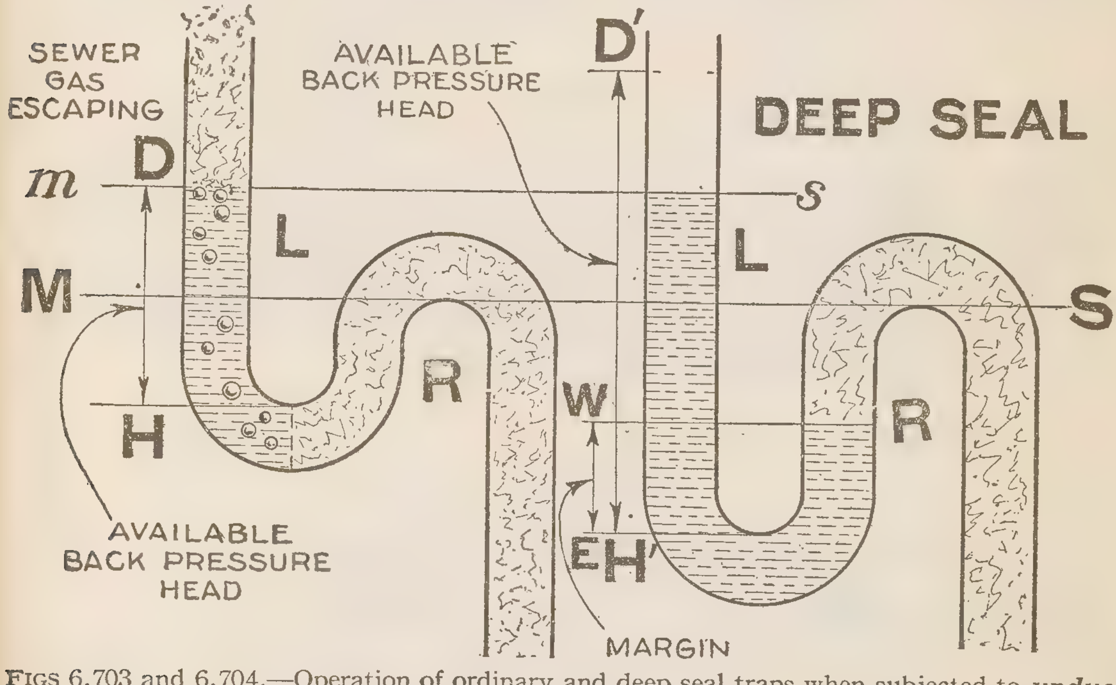
FIGS. 6,699 and 6,700.—Behaviour of gravity and buoyancy types of mechanical trap during discharge from fixture. ***Observe, heavy ball*** (fig. 6,699) is forced up and light ball (fig. 6,700) forced down by discharge current from fixture.



FIGS. 6,701 and 6,702.—Comparsion of ordinary and deep seal S traps. Note in fig. 6,702, excess depth of seal available to meet abnormal conditions.

Figs. 6,699 and 6,700 show the operation of gravity and buoyancy mechanical traps during discharge from fixture.

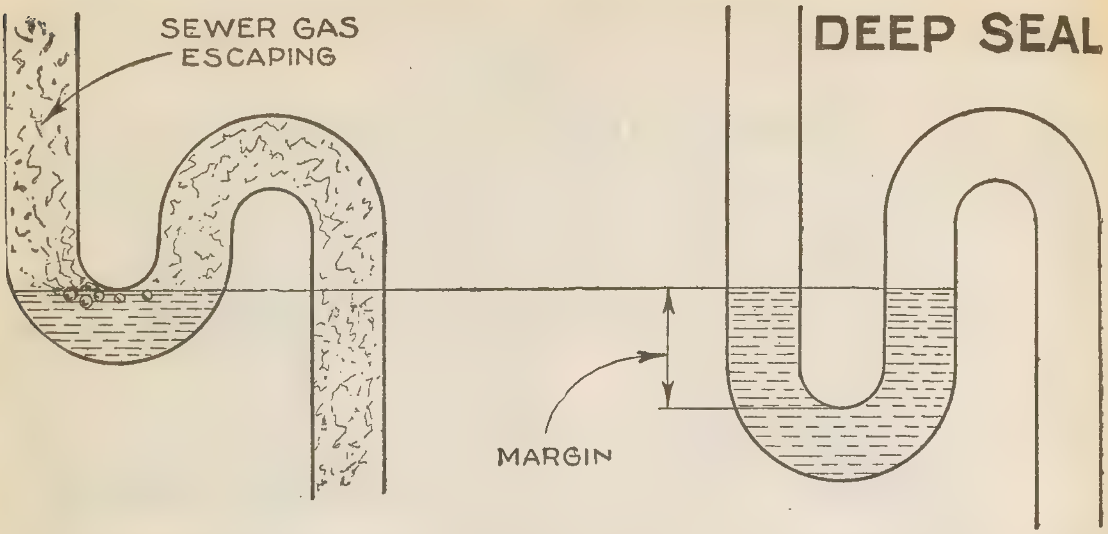
Operation of Deep Seal Traps.—The ordinary depth of seal is sufficient for traps that are not subjected to any unusual conditions such as undue back pressure, or long periods of non-use. A comparison of the ordinary and deep seal trap is shown in figs. 6,701 and 6,702; here, the excess or reserve



FIGS 6,703 and 6,704.—Operation of ordinary and deep seal traps when subjected to *undue* ***back pressure. In the ordinary seal trap,*** (fig. 6,703) undue back pressure will force *all* water out of leg L, into leg R, to elevation *m s*, destroying the seal, thus allowing sewer gas to escape. ***In the deep seal trap*** (fig. 6,704) the same amount of back pressure will force *some* of the water out of leg L into leg R, leaving a margin of seal as E W, preventing escape of sewer gas. Comparing the two traps it is evident that a seal H′ D′, much larger than H D, is available as a back pressure head to prevent the escape of sewer gas.

depth of seal of the deep seal trap to meet abnormal conditions is plainly shown. This reserve depth is desirable where there is liable to be undue back pressure as in figs. 6,703 and 6,704, or long periods of non-use as in figs. 6,705 and 6,706.

Operation of Grease Traps.—More or less grease is discharged



FIGS. 6,705 and 6,706.—Operation of ordinary and deep seal traps when subjected to ***long periods of non-use.*** This is a case of loss of seal by evaporation and evidently since the deep seal trap holds more water than the ordinary trap, it will take longer to evaporate the water out of the deep seal trap, than out of the other. ***The illustrations show,*** loss of seal in the ordinary trap by evaporation, and a good margin of seal depth remaining in the deep seal trap after an equal amount of evaporation showing that a deep seal trap should be used when liable to be subjected to long periods of non-use.

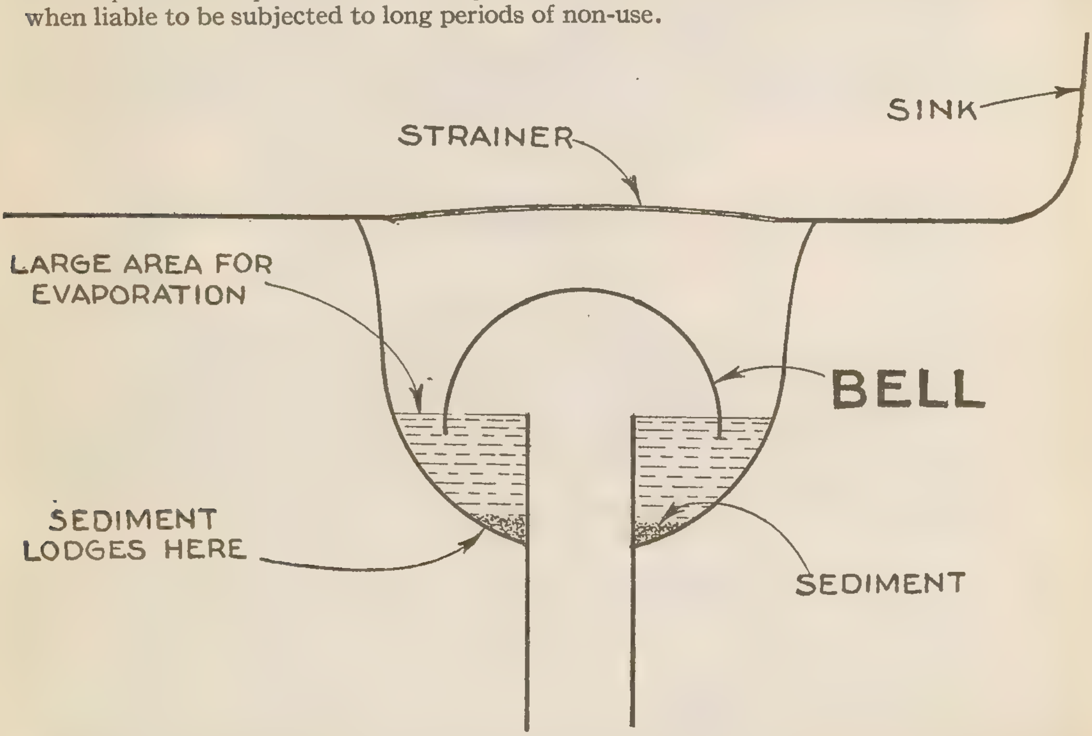


FIG. 6,707.—Old fashioned bell trap for sink. ***It is liable*** to become choked by sediment lodging in the bottom and soon looses its seal by evaporation. *This type of trap should not be used.*

through the waste from the kitchen sink, and to protect the drainage system from the accumulation of congealed grease adhering to the pipe walls a grease trap is provided.

The principle upon which a grease trap operates is that *contact with cold surfaces causes warm or fluid grease to separate from the liquid by congealing.* Accordingly, the first requisite in construction is that *the walls of the grease trap be cold.*

This is obtained most efficiently by providing a water jacket so that

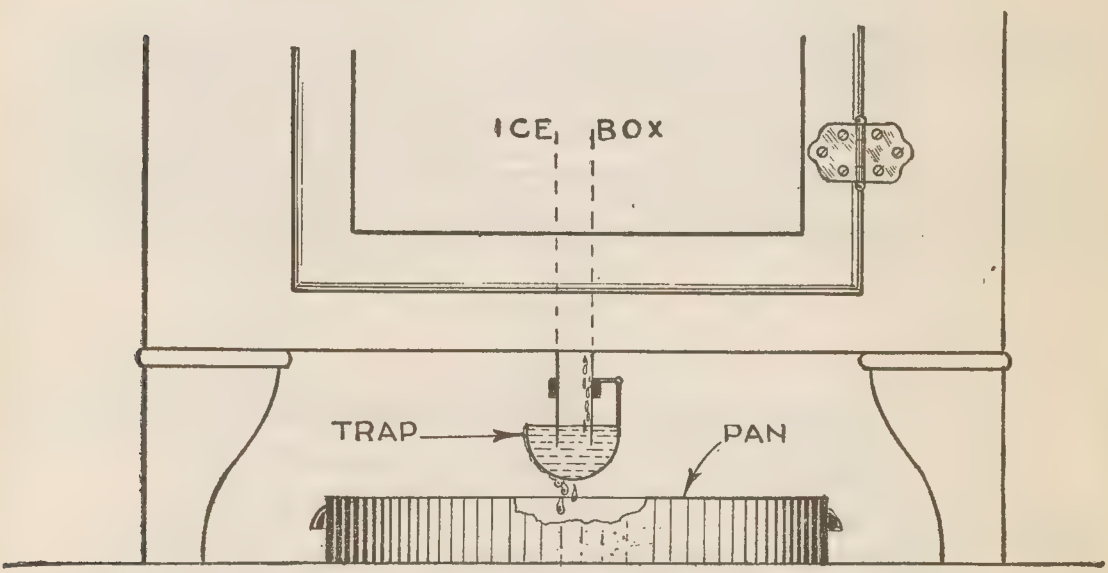
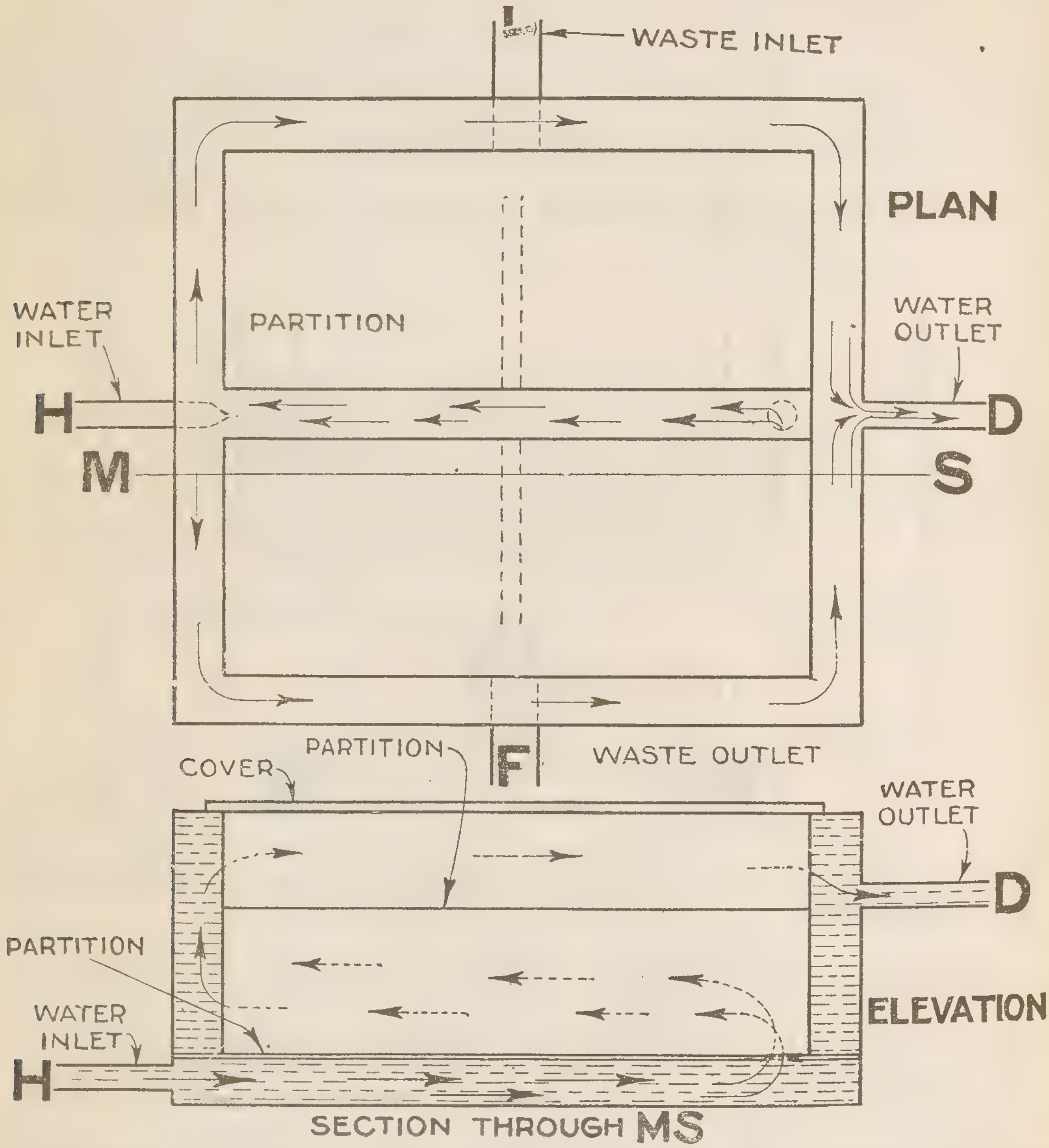


FIG. 6,708.—Refrigerator trap located on discharge end of drip pipe from ice chamber. ***The object*** of this trap is to prevent warm air entering through the drip pipe; it also serves to keep out insects, etc.

the entire trap with exception of the top is surrounded by running cold water. The water pipe supplying the kitchen sink is connected at the inlet and outlet ends of the water jacket, thus cold water flows over the trap surfaces every time water is drawn at the sink. There is a baffle or partition wall across the center of the trap to prevent the waste entering the trap, short circuiting to the outlet and carrying the grease with it. These requirements are shown in figs. 6,709 to 6,711. A water jacketed trap is called a "chilling trap".

Operation of Closet Traps.—In the development of the water

closet a great multiplicity of types have been introduced. Of the survivors, and with respect to the trap action, closets may be classed as:



FIGS. 6,709 to 6,711.—Water jacketted grease trap. The arrows in figs. 6,709 and 6,710 show circulation of the cooling water, first traversing the bottom, then the partition and lastly, the side walls. ***In operation,*** cooling water enters at H, and leaves at D, thus keeping all surfaces cool. Water from sink carrying melted grease enters at L, and striking the cold

Note—FIG. 6,711 on next page

1. Hopper.
2. Wash out.
3. Syphon.
4. Syphon jet.
5. Pneumatic syphon.
6. Semi-pneumatic syphon.

The wash down or hopper closet has a conical bowl, as shown in fig. 6,712, which is attached to a trap of any desired form.

For outdoor use, where there is danger of the trap freezing, the hopper may be long as shown in fig. 6,713. Short hoppers are fitted with a flushing tank overhead, long hoppers with a valve below frost line.

In the washout closet, as shown in fig. 6,714, there is a pan or dish containing a shallow puddle of water to receive the excreta.

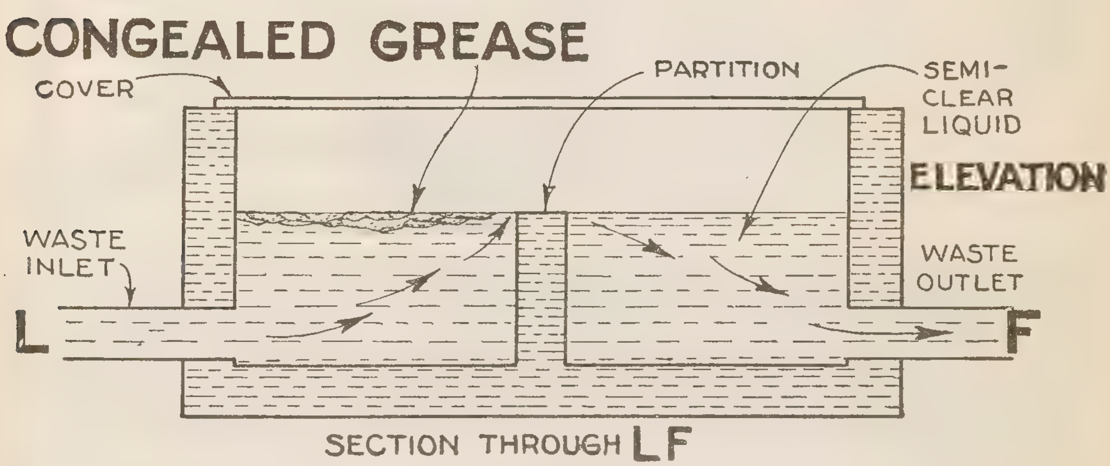
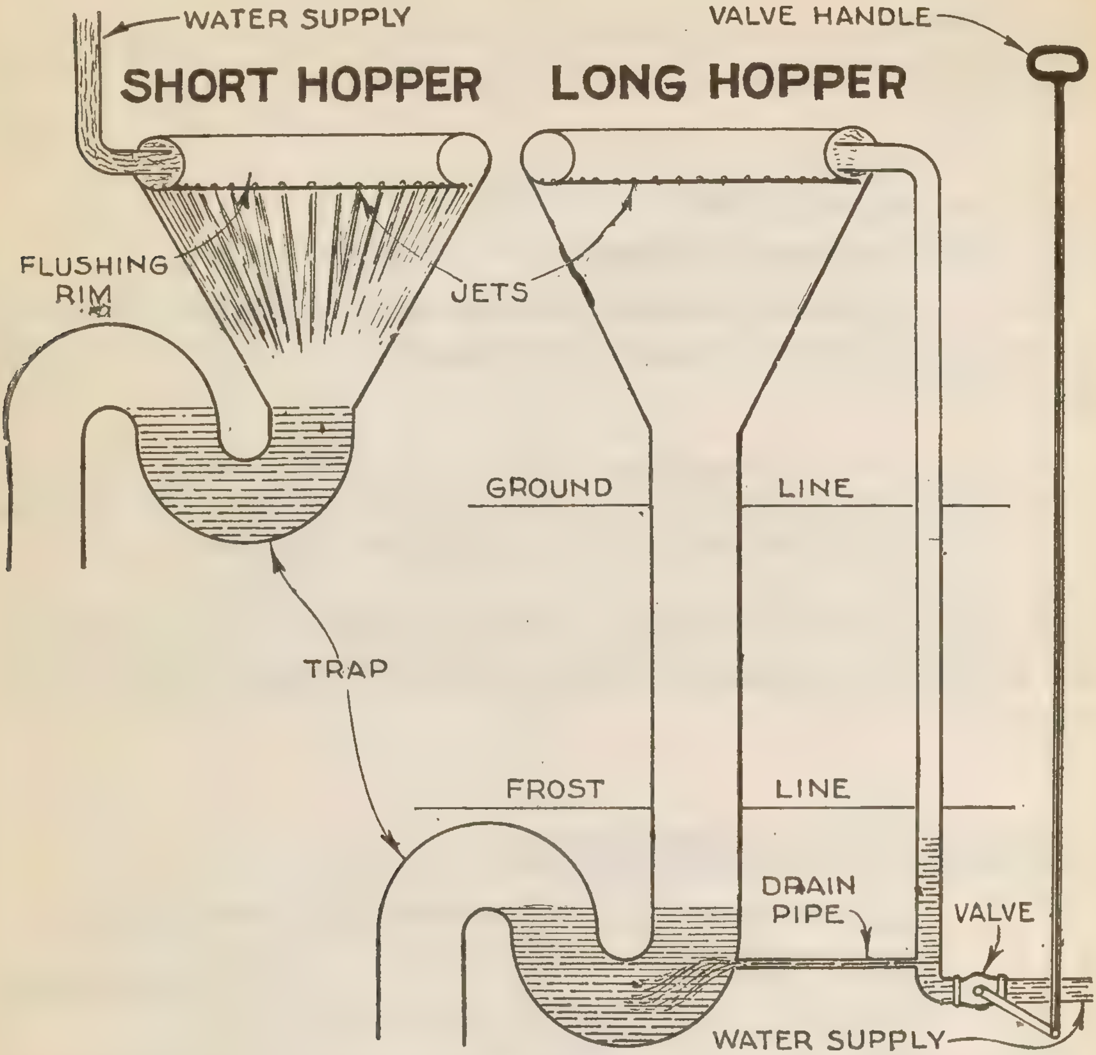


FIG. 6,711

FIGS. 6,709 to 6,711—*Text Continued.*

walls causes the grease to congeal, the latter being lighter than the water rises and floats. The water flows over the partition and down to the outlet F, most of the grease being held in the first compartment by the partition. From time to time the cover is removed and the congealed grease skimmed off.



FIGS. 6,712 and 6,713.—Short and long hopper closets. Each is provided with a *flushing rim* to evenly distribute the flush water so that the entire hopper surface will be scoured. In the short hopper type (fig. 6,712), the trap is connected close to the bowl. For anti-freezing service a long hopper is provided set so that the trap will be below the frost line as shown in fig. 6,713. The flush water is controlled by the valve which has a long stem. ***After flushing,*** the water in the supply pipe will drain down to the trap water level through the small drain pipe. This not only drains the supply pipe but insures ample trap water after flushing.

NOTE.—Wherever there is a systematically organized and well conducted board of health, it has been well suggested that their duties should include some power of veto upon the right of building houses upon unwholesome sites. All scavenging and disinfecting must, in order to be effective, be thorough and systematic—which conditions can only be secured by the most careful public direction and supervision.—*Waring.*

NOTE.—***The drainage question*** is essentially a question of health and life. Dr. George Derby stated the whole case when he said "The well are made sick and the sick are made worse for the simple lack of God's pure air and pure water." Air is infected and water is tainted, not only by defects in the public works, but quite as often and quite as dangerously by imperfections in household arrangements.—*Gray.*

The puddle of water is to prevent the excreta adhering to the dish. In operation, when the flush is applied, it "washes out" (hence the name) the excreta over the edge of the dish into the trap and soil. A disadvantage of this closet is that the seal S, cannot be of full depth because the excreta, paper, etc., will require a larger and more forcible flush than available for proper ejectment.

Another point in design is that the depth of puddle P, should not be

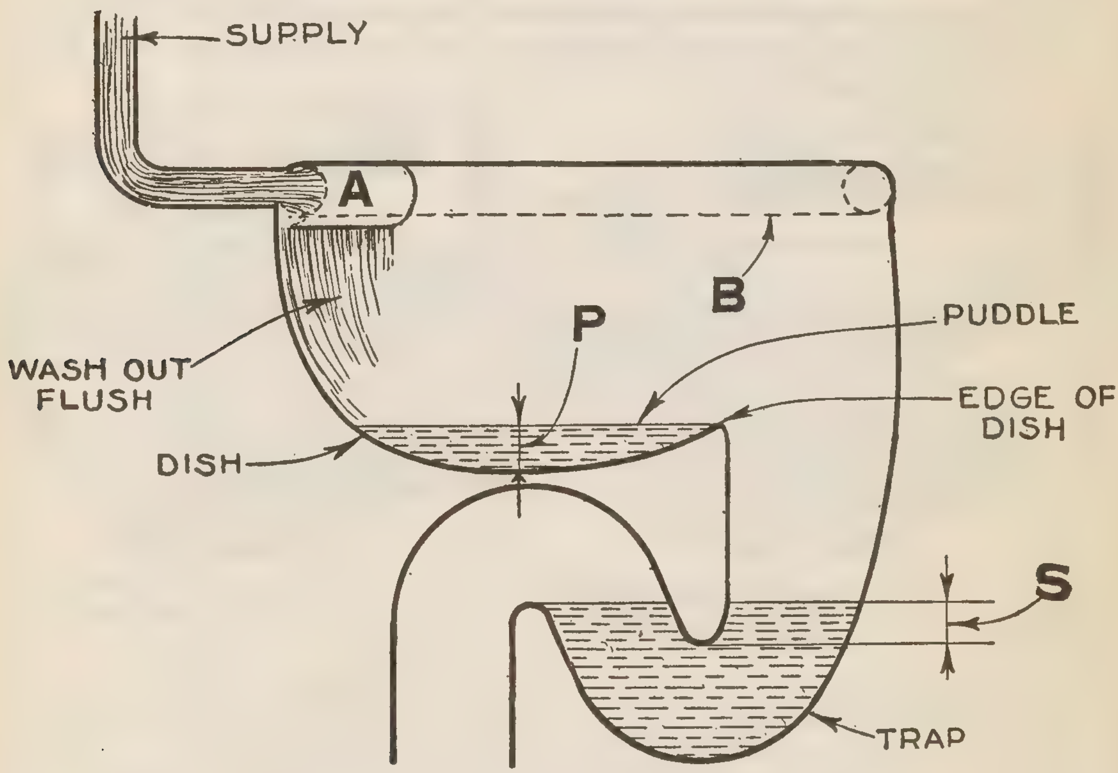


FIG. 6,714.—Wash out closet. ***In operation,*** the flushing water is distributed by the flushing run through either an annular slot, or perforations to evenly distribute the flush. The flush in some types is restricted to the sluice A, but an improvement consists in extending a run all around as indicated in dotted lines so that the entire bowl surface is scoured. In any case a sluice getting an extra wash across the disk is necessary to sweep the excreta over the edge. After discharge through the trap, the water in the pipe from a high tank connection insures filling the trap. Low down tanks are constructed to give an after fill for the same purpose.

more than 1¾ ins., otherwise the flush water may pass under the solid excreta and fail to carry it over the edge of the dish; if made less than 1½ ins. deep the excreta may adhere to the dish.

Figs. 6,715 to 6,718 show the syphon closet and its various modifications.

The distinguishing feature of this class is the strong syphonage secured partly by the crooked outlet and the several jet arrangements.

The *pneumatic syphon* closet has two traps, as shown in fig. 6,719.

In operation, the flushing water when started, surrounds the conical upper end of the air pipe, forming part of the exhaustion. The water

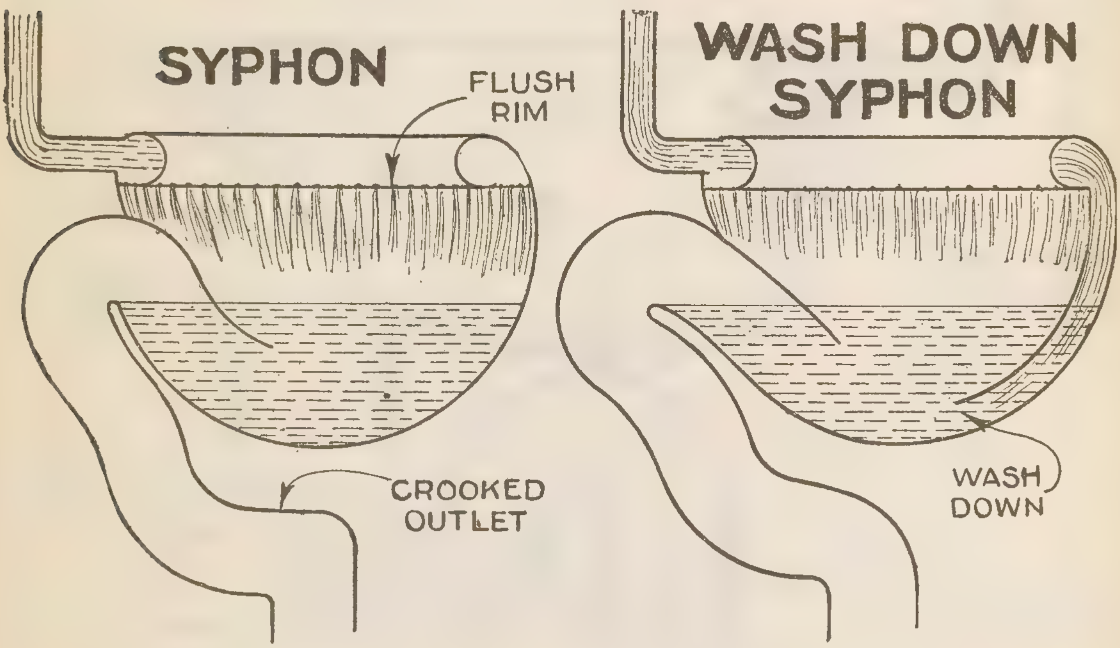


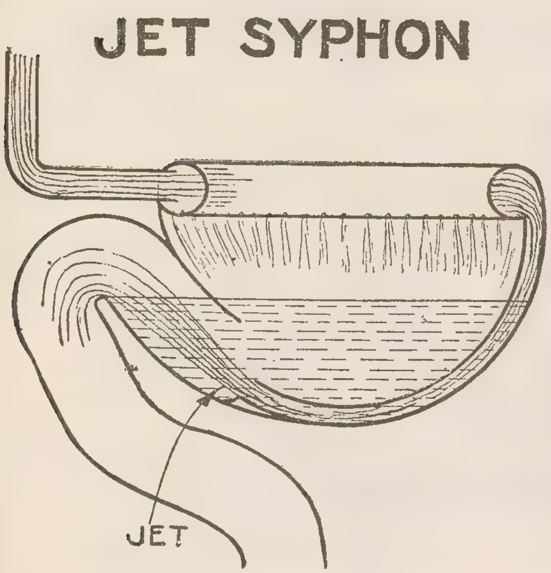
FIG. 6,715.—Syphon closet. ***In operation,*** the flushing rim distributes the flush water. In flushing the trap water is forced into the soil pipe causing a partial vacuum which syphons off the contents of the bowl. The crooked outlet breaks up the discharge and increases the strength of the syphonage.

FIG. 6,716.—Wash down syphon closet. This is the same as the syphon closet with exception of the wash down opening supplied with water by connecting with the flushing ring as shown. ***In operation***, a strong stream of water, in addition to that discharged through the flushing ring, "washes down" the contents of the bowl and helps to make the syphonage more energetic. The crooked outlet breaks up the discharge and increases the strength of the syphonage.

flowing through the exhauster draws air out of the space between the two traps, causing the latter to fill with water, the initial condition for starting a strong syphonic action. When the water supply is shut off, air enters exhauster and air pipe, admitting air between the two traps, thus breaking the syphon.

The *semi-pneumatic* is a combination of the pneumatic and syphon jet principles.

In operation, the flush water divides immediately after entering the bowl, part going to the syphon jet and part to the flush rim, as usually arranged, except that the part of the water which operates the jet passes through a contracted nozzle. This nozzle has a trap to prevent air getting into the flush pipe or rim of the closet from the space between the two



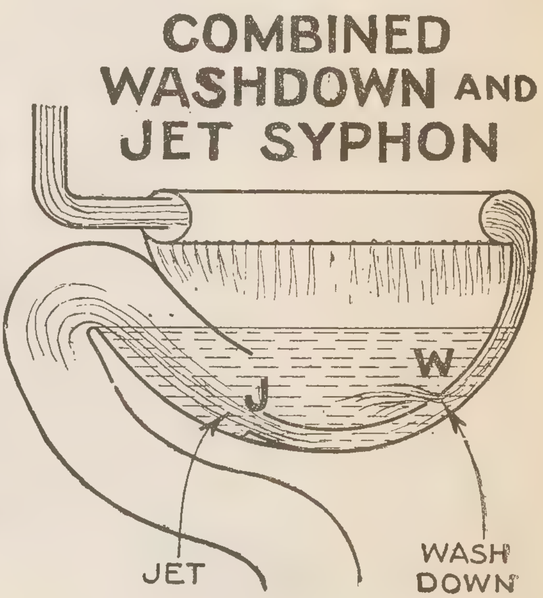


FIG. 6,717.—Jet syphon closet. In addition to the usual flushing rim, there is a small hole at the bottom of the bowl pointing toward the trap, and is connected with the flushing rim as shown. ***In operation,*** the flushing water is evenly distributed around the bowl by the flushing rim; at the same time, a stream or jet of water flows out of the small hole and forces its way through the trap water in a jet carrying part of the trap water with it into the soil pipe, there forming a partial vacuum which syphons the contents of the bowl into the soil pipe. The crooked outlet breaks up the discharge and increases the strength of the syphonage.

FIG. 6,718.—Combined wash down and jet syphon closet. This closet as shown has wash down and jet openings W and J, both receiving their water by connection with the flushing ring. ***In operation,*** water issuing through hole W, washes down the contents of the bowl and that through J, quickly starts and augments the strength of the syphonage,

traps. The trap helps to spray the water as it issues from the injection nozzle, by which action the fouled air between the traps is exhausted with the water into the soil pipe.

Loss of Seal.—A trouble frequently encountered with traps is the disappearance of the trap water which renders the trap

inoperative, allowing the sewer gas to escape; this is known as "loss of seal." The seal may be broken in several ways, as by:

1. Evaporation.
2. Capillary attraction.
3. Back pressure.
4. Oscillation.

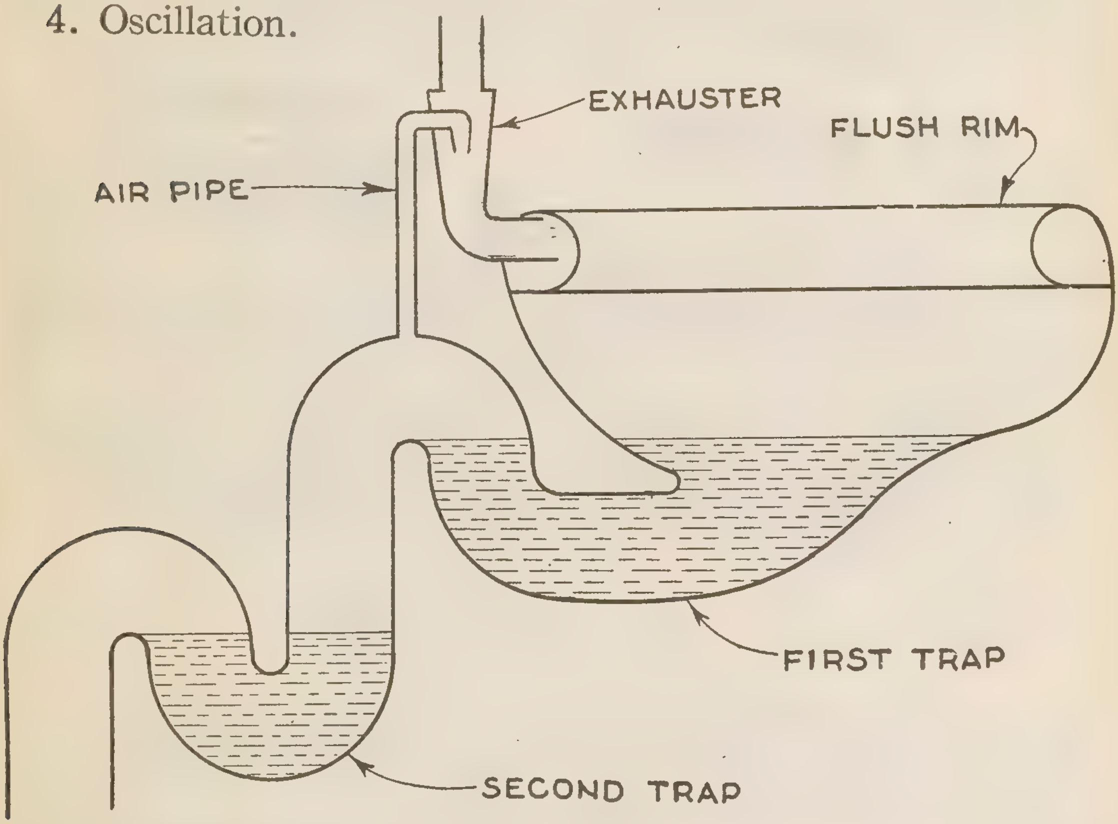
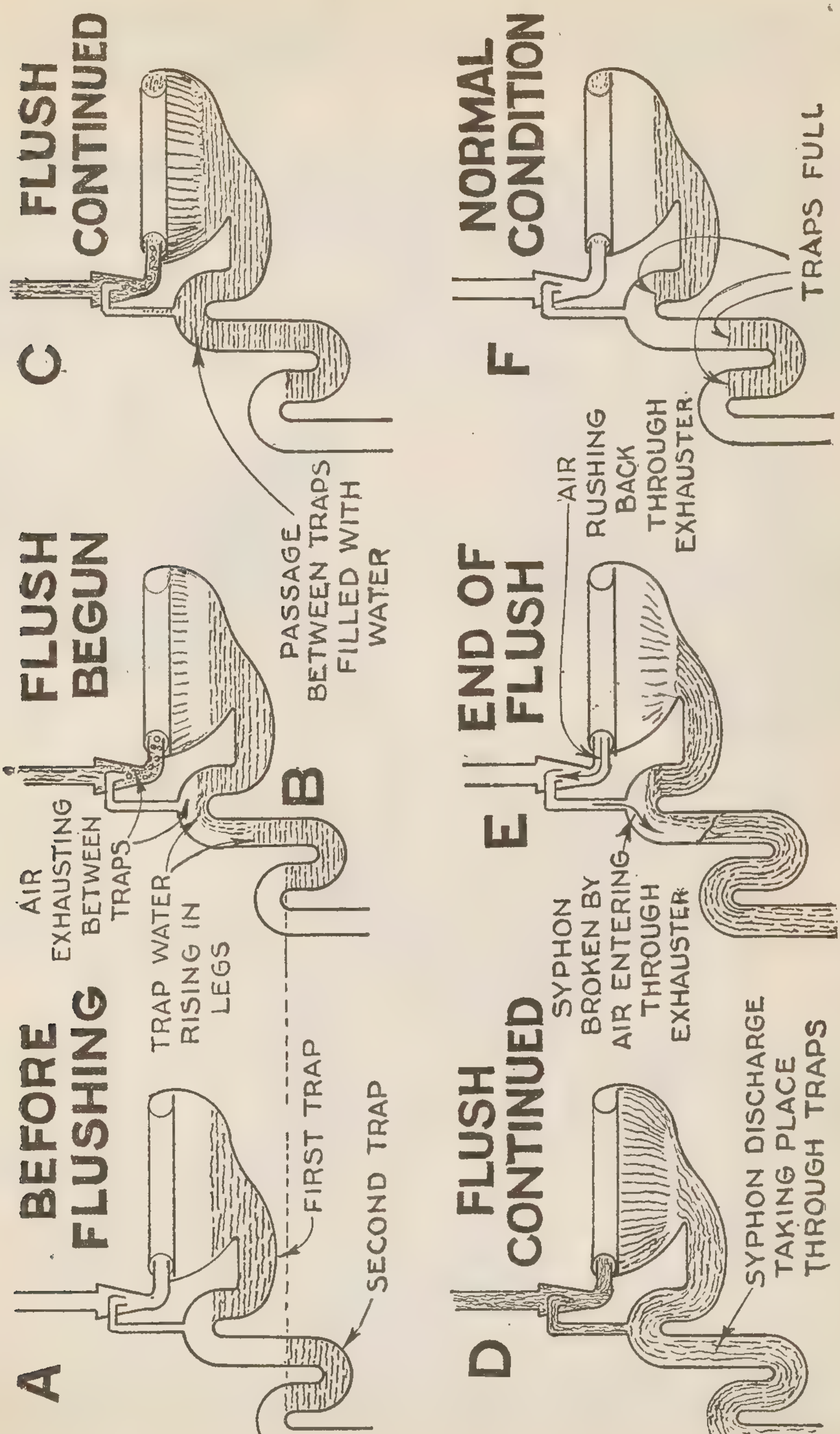


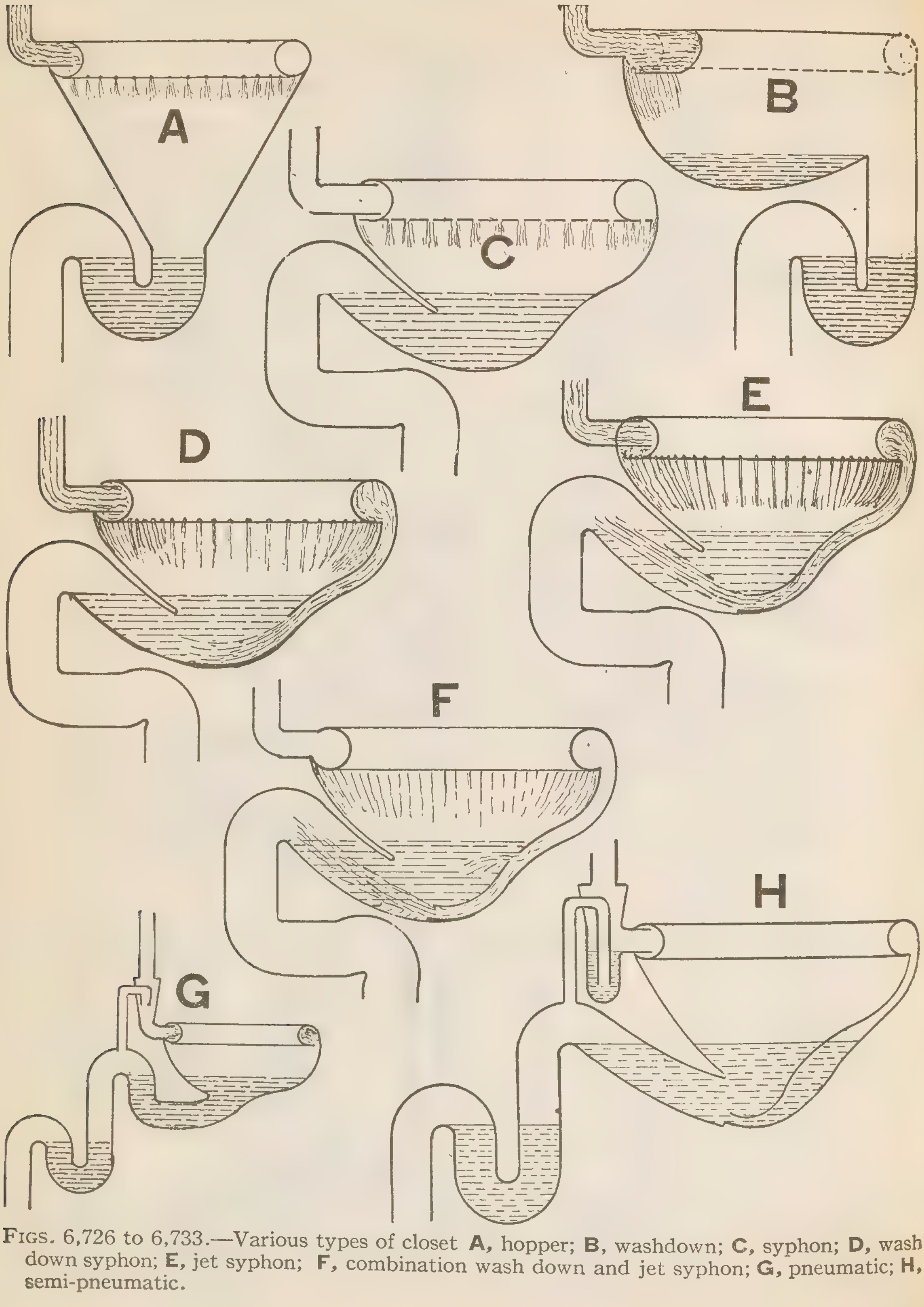
FIG. 6,719.—Pneumatic closet. ***Its essential feature*** comprises two traps with an exhauster connected between traps as shown.

5. Syphonage.
6. Momentum.
7. Asperation.

NOTE.—***The various items of the work of draining*** the house concern both the architect and engineer. The latter, in so far as it relates to the admission into the public works of sewerage of the liquid refuse of the house, and the making of the necessary provisions to prevent any injury being done to the public interest by reason of careless or improper connection or the admission of improper substances; the former from the still more important considerations connected with the proper arrangement of the house as a domicile for human beings.



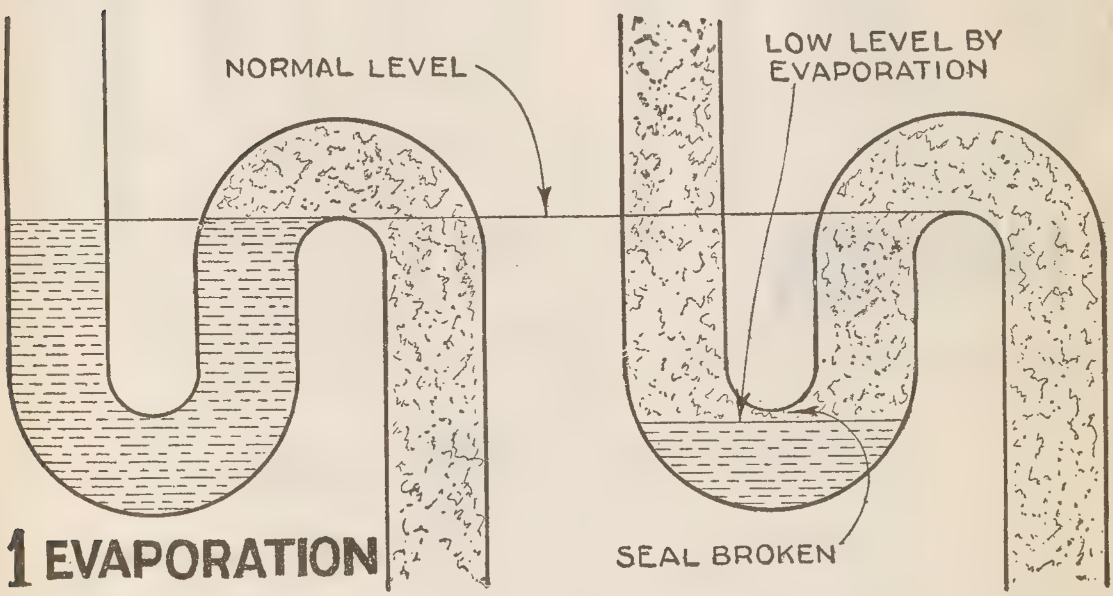
FIGS. 6,720 to 6,725.—Operation of pneumatic closet **A**, before flushing; **B**, flush begins; **C**, flush continued; **D**, flush continued; **E**, end of flush; **F**, normal condition.



FIGS. 6,726 to 6,733.—Various types of closet **A,** hopper; **B,** washdown; **C,** syphon; **D,** wash down syphon; **E,** jet syphon; **F,** combination wash down and jet syphon; **G,** pneumatic; **H,** semi-pneumatic.

Evaporation.—When a trap is not in use for a long period, the water gradually evaporates, resulting finally in loss of seal as shown in figs. 6,734 and 6,735.

Capillary Attraction.—By definition this is *a manifestation of surface tension observed in all liquids.* In fine tubes and bores, the surface tension is sufficient to balance a small column of liquid maintaining it at a level above the outside. In a trap any accumulation of lint, hair, or a string over the crown of a trap as in fig. 6,737 will act similarly and carry off the trap water.

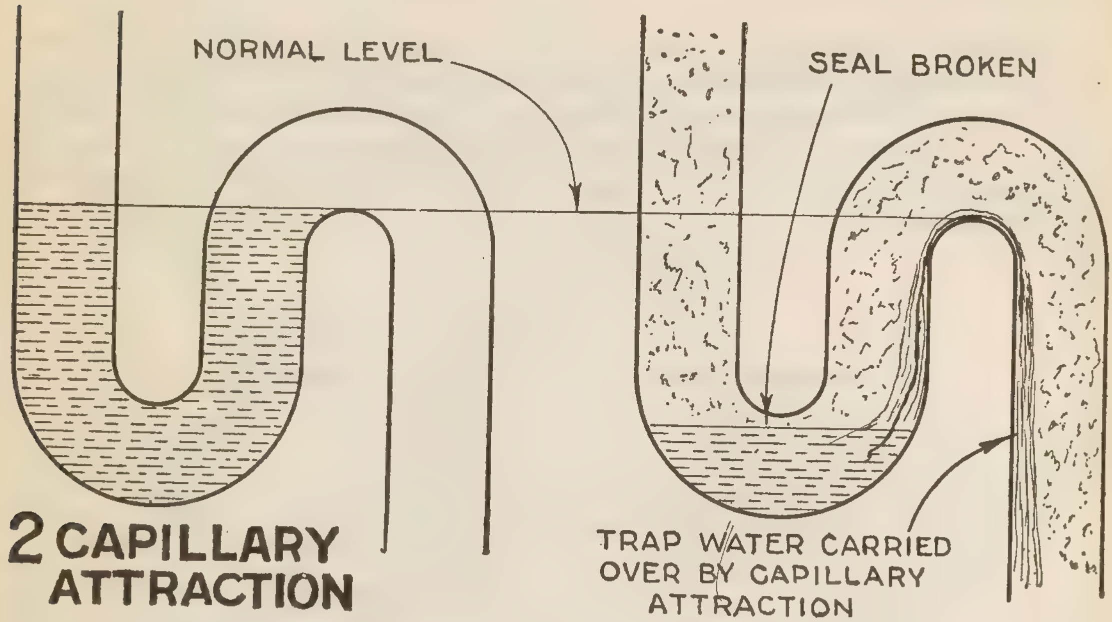


FIGS. 6,734 and 6,735.—*Loss of seal: 1. By evaporation.*

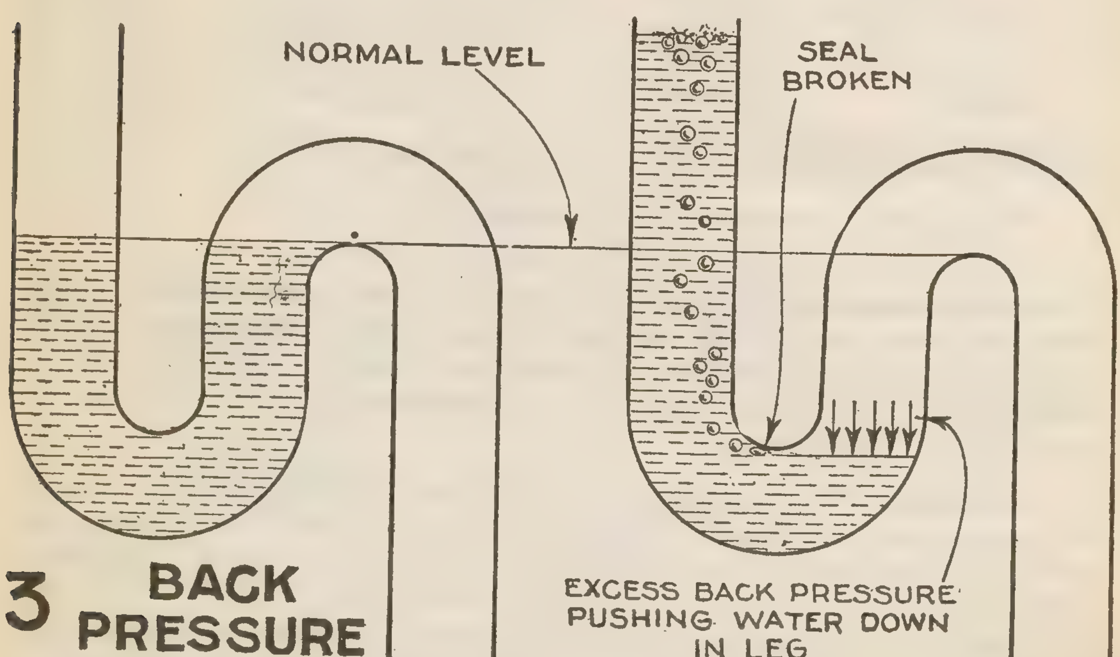
Back Pressure.—If the sewer be unvented or improperly vented, under some conditions gas will be generated therein, which will produce a back pressure in the drainage pipes, in some cases sufficient to force the trap water down in one leg far enough to break the seal and allow the gas to excape as in fig. 6,739.

Oscillation.—This generally occurs in high buildings having a long soil, waste and vent stacks. When puffs of wind blow down through the ventilation pipe, there is a tendency to force the seal of the traps back towards the fixtures as in fig. 6,740, followed by wind conditions which the next instant may produce a partial vacuum in the system, drawing the trap water back and causing some of it to spill over the crown as in fig. 6,741. If these conditions continue, giving rise to alternate excess

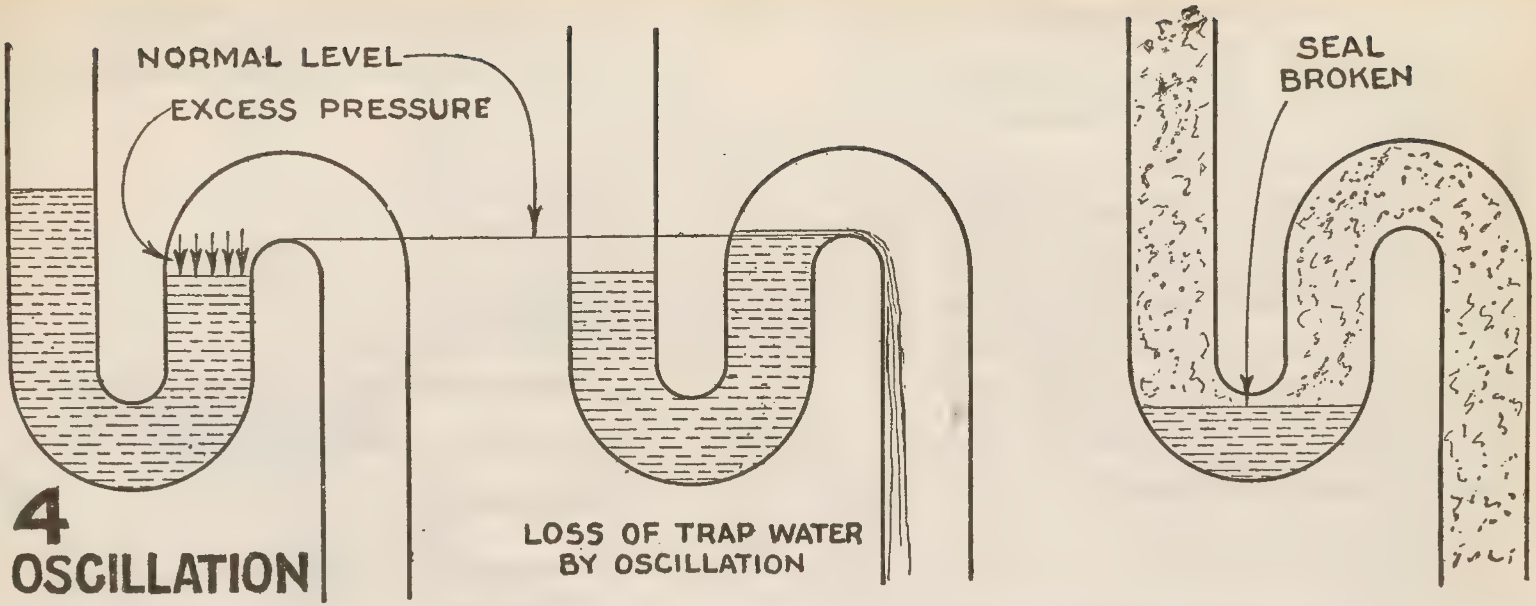
pressure and vacuum with attending "oscillations" of the trap water, enough will eventually be lost to break the seal, as in fig. 6,742.



FIGS. 6,736 and 6,737.—*Loss of seal: 2. By capillary attraction.* In Fig. 6,737 note string hanging over leg and into waste pipe.



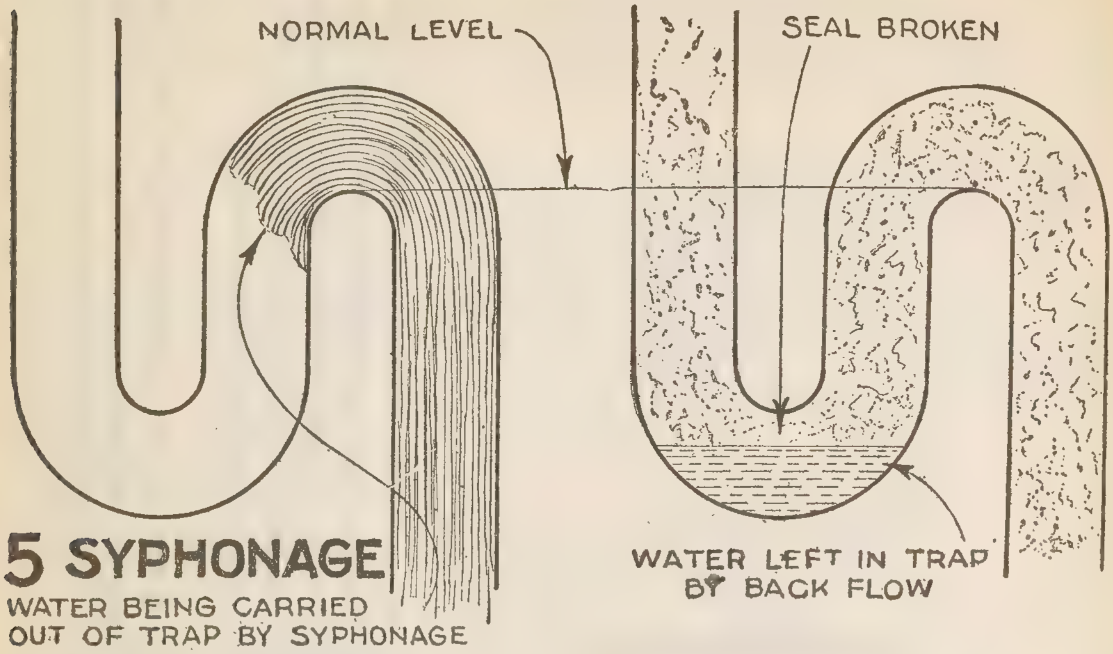
FIGS. 6,738 and 6,739.—*Loss of seal: 3. By back pressure.*



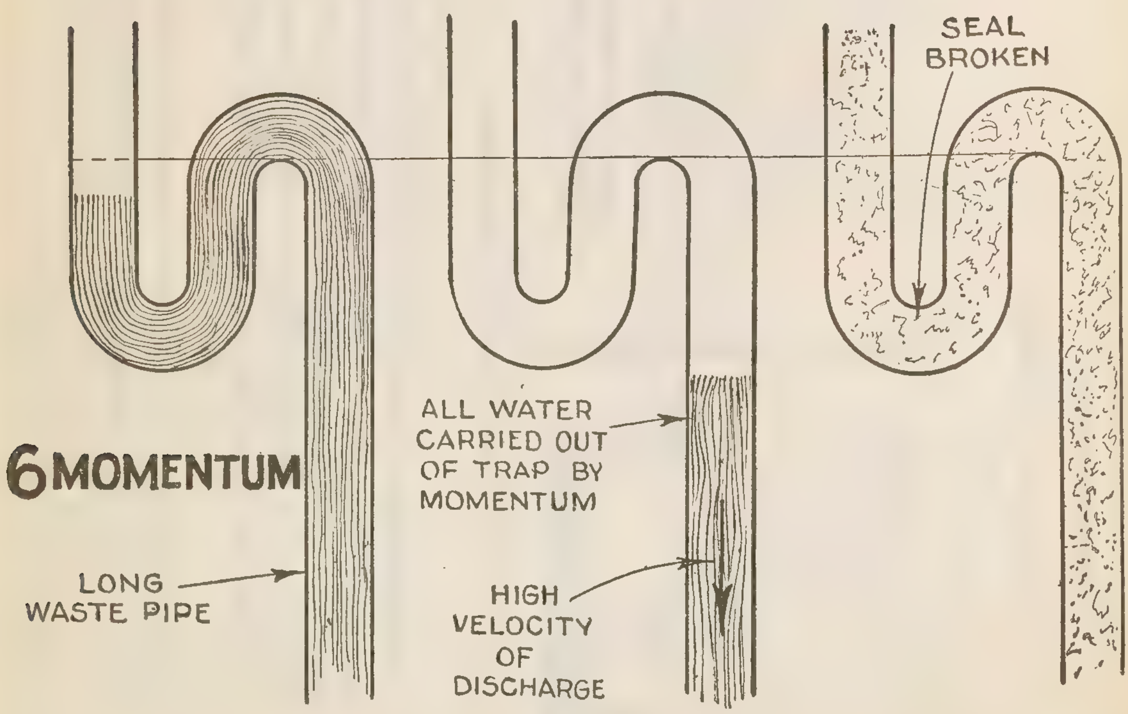
FIGS. 6,740 to 6,742.—*Loss of seal: 4. By oscillation.*

Syphonage.—During fixture discharge the water fills the entire trap and waste pipe for some distance below the trap. The weight of water is accordingly much greater on the outlet side of the trap than on the inlet side, which tends to cause the water in the trap to rise to the outlet and follow the larger body of water over the crown into the waste pipe, leaving the trap without any water except what may fall back, and this sometimes, as shown in fig. 6,744, is not sufficient to form a seal.

Momentum.—When the discharge pipe has an extra long vertical run a high velocity of discharge is attained and the momentum of the moving column of water may in an extreme case be sufficient to carry all the water over the crown as in fig. 6,746, entirely emptying the trap and allowing the sewer gas to escape as in fig. 6,747.



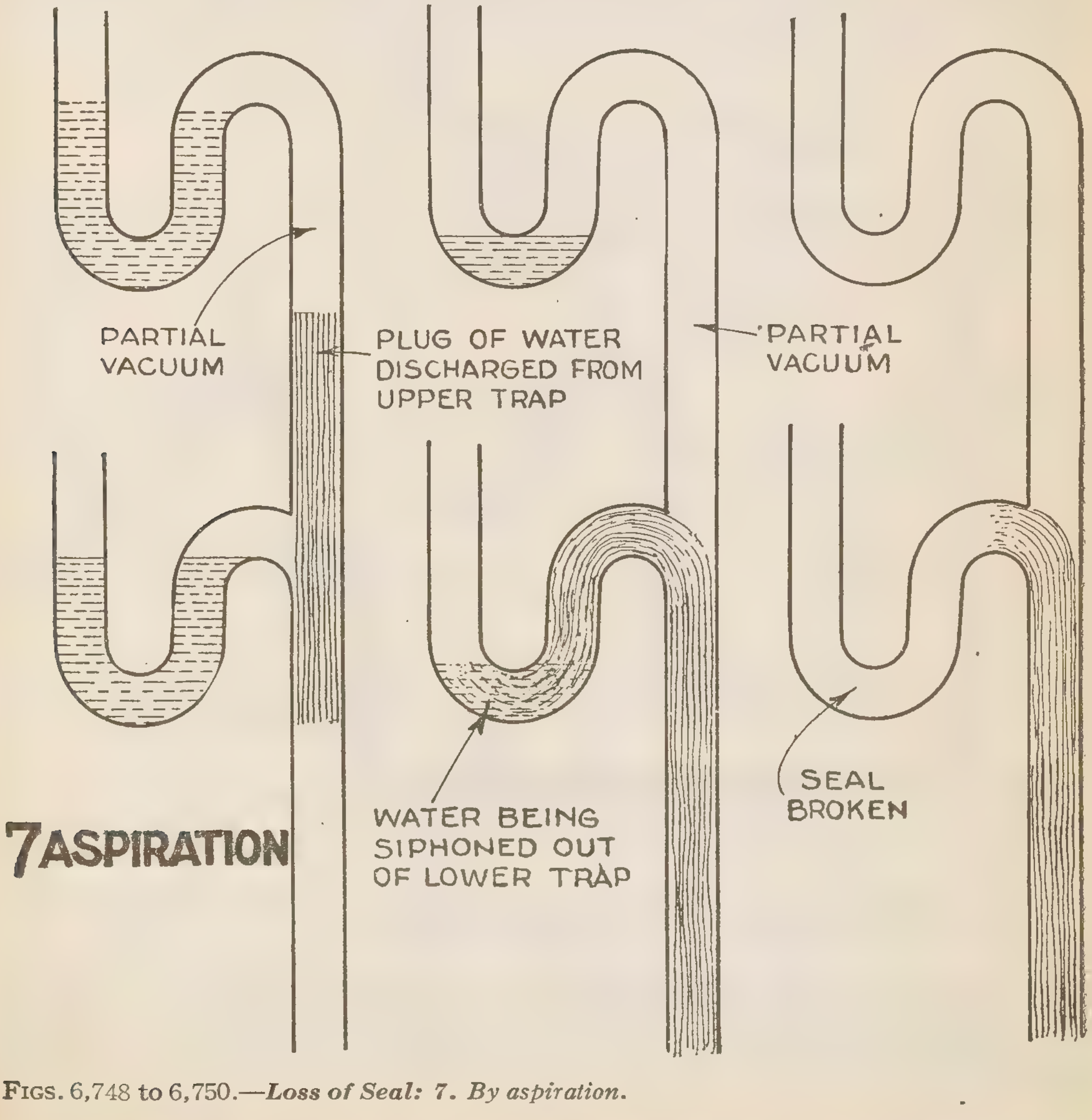
FIGS. 6,743 and 6,744.—*Loss of Seal: 5. By syphonage.*



FIGS. 6,745 to 6,747.—*Loss of Seal: 6. By momentum.*

Aspiration.—By definition the term *aspiration* means *the drawing in of air*. A trap can lose its seal by aspiration, on the discharge of a trap located above and connected to the same stack as in fig. 6,748. As here shown, the discharge in the form of a solid "plug" of water is passing down the stack and creating a partial vacuum behind it. As it passes the lower trap the water in this trap flows out into the vacuum as in fig. 6,749, thus breaking the seal and in extreme cases emptying the trap as in fig. 6,750.

Venting.—A proper system of venting must be provided to allow the free passage of waste from the fixtures, otherwise



FIGS. 6,748 to 6,750.—*Loss of Seal: 7. By aspiration.*

the drainage system would become air bound, which would check the movement of the waste. The venting system consists of:

1. Ventilation stack.
2. Fresh air inlet.
3. Trap vents.

The ventilation stack and fresh air inlet have already been explained. The additional illustration, fig. 6,751, will show the relation of these vents and ascending ventilating current

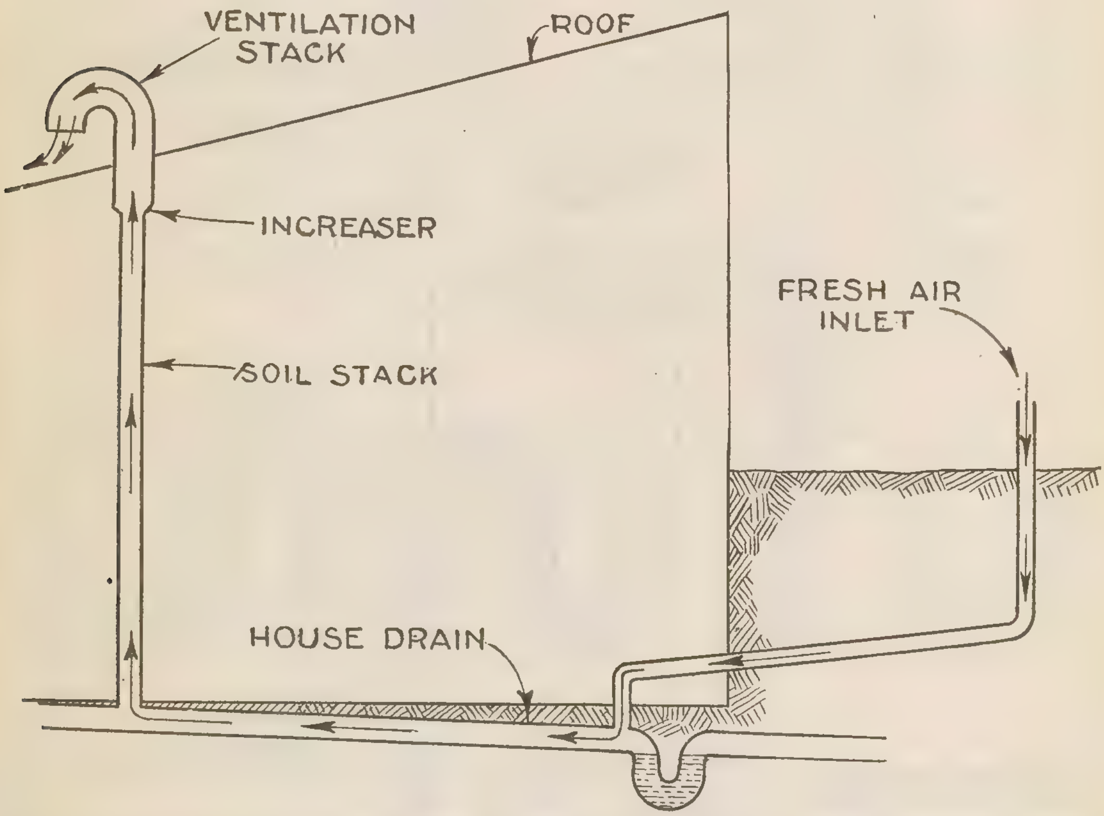


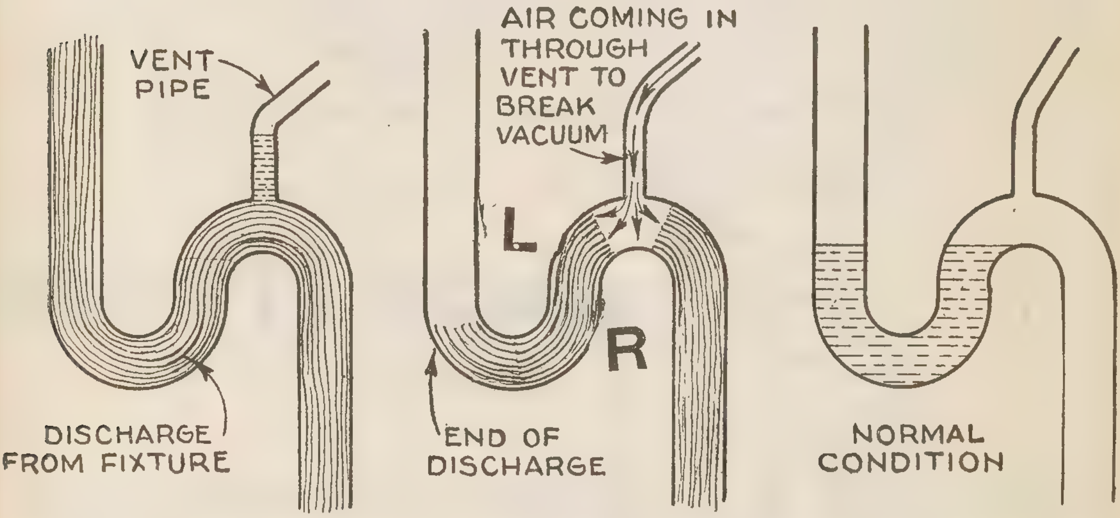
FIG. 6,751.—Main vents of ventilation system showing ventilation stack and fresh air inlet with normal ventilating fresh air current indicated by arrows.

of fresh air which occurs under favorable conditions, simiiar to draught in a chimney. This is intended to prevent the accumulation of sewer gas in the system.

Of course at times the current may reverse and foul air flowing off through the fresh air inlet; because of this possibility the fresh air inlet must be located and constructed in accordance with regulations to prevent danger to the occupants of the building.

To prevent the loss of seal by syphonage, back pressure, etc., traps should be vented.

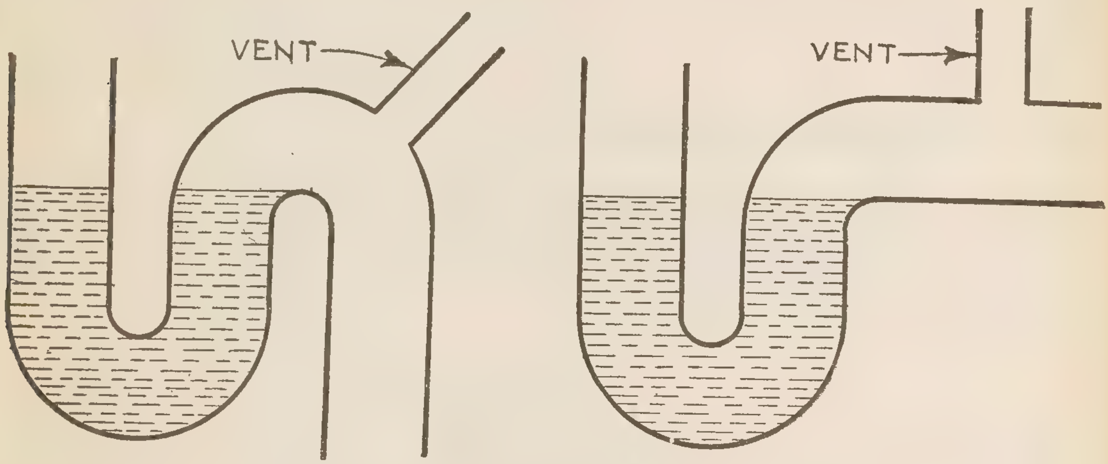
This is done by connecting a vent pipe to each trap so that air may be admitted and thus destroy any vacuum due to syphonage. The vent pipe is connected at various points; fig 6,752 shows it connected at the crown but this is not the best location.



FIGS. 6,752 to 6,754.—Trap with vent pipe connected to crown illustrating the principle of venting in preventing syphonage.

In operation, as soon as the discharge has passed out of the leg L; of the trap (fig. 6,753), the tendency in an unvented trap would be to syphon the water out of leg R, but at the instant here depicted, air rushes in through the vent pipe as indicated by the arrows and breaks the vacuum, allowing the water in R. to fall back and re-establish the seal as in fig. 6,754. While theoretically the proper point for connecting the vent is at the crown of the trap, it has the objection of bringing fresh air directly upon the seal of the trap, which accelerates evaporation. By connecting the vent a little to the side of the crown as shown in figs. 6,755 and 6,756, the evaporation is less rapid.

The method of venting just shown in figs. 6,752 to 6,754 is called *crown venting* as distinguished from a better method known as *continuous venting*.



FIGS. 6,755 and 6,756.—Vent offset to side of crown to reduce rate of evaporation.

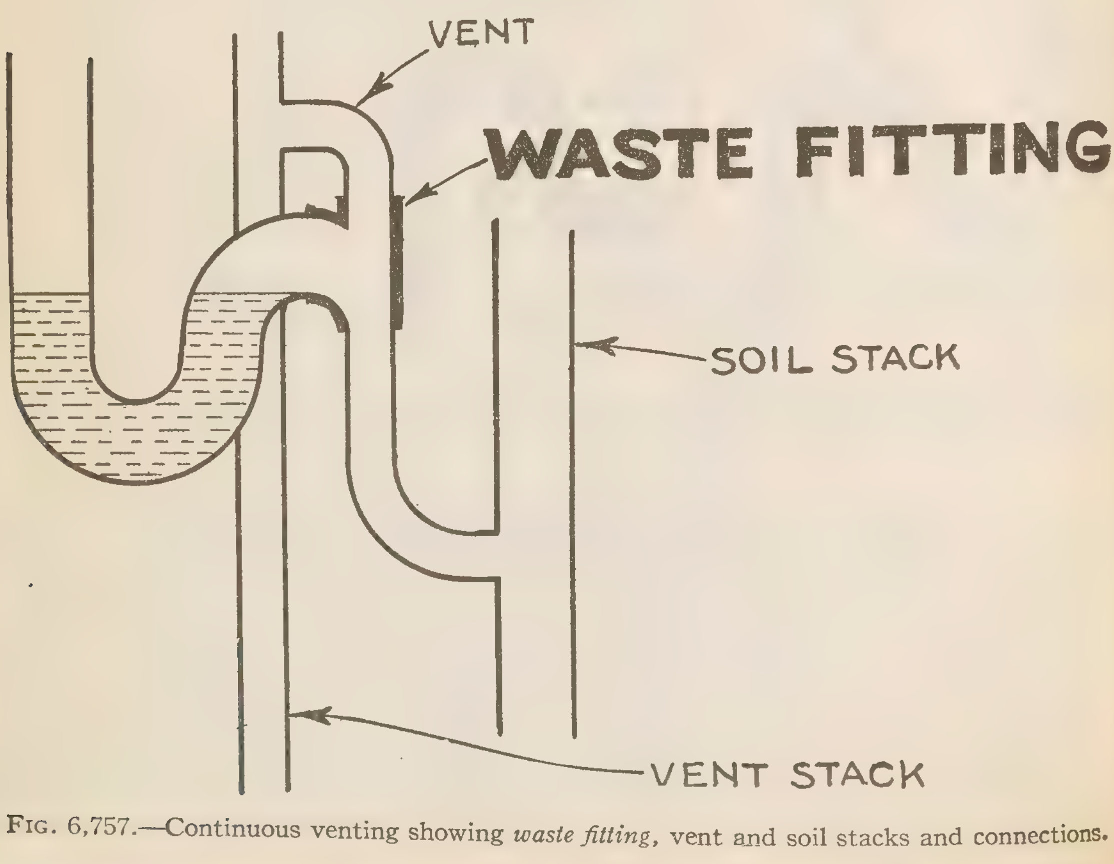


FIG. 6,757.—Continuous venting showing *waste fitting*, vent and soil stacks and connections.

In general, continuous venting consists *in connecting the outlet of the trap into a waste fitting located in such a manner that a vent pipe may be connected into the top of the same fitting* as shown in fig. 6,757.

The advantage of continuous venting over crown venting is the less danger of the vent connection becoming fouled with grease, lint, etc. The supply of air being brought in less directly on the trap tends to lessen the rate of evaporation. In continuous venting the outlet for the trap should be run nearly horizontally into the waste fitting.

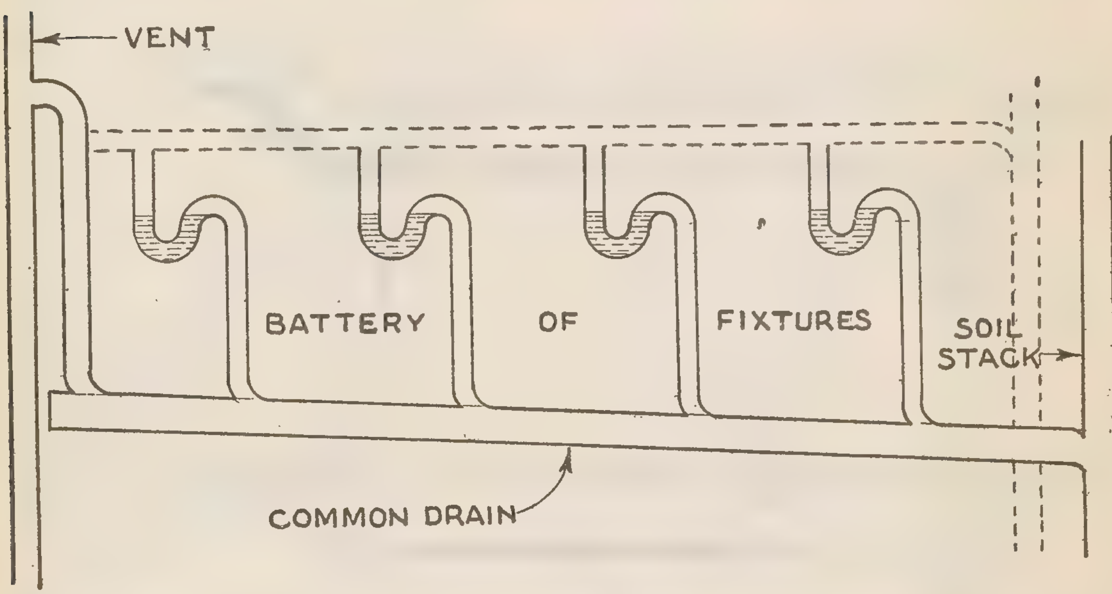
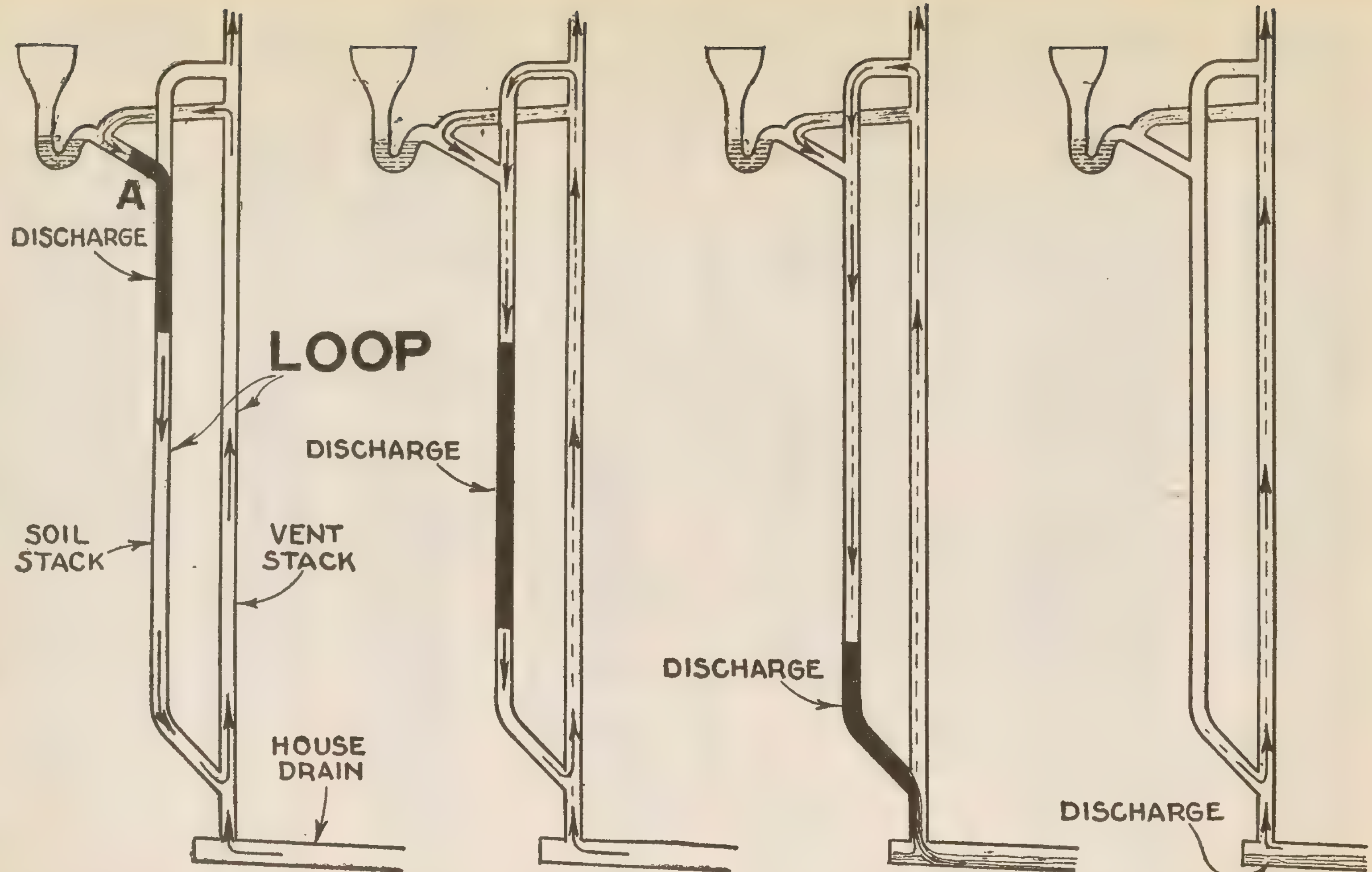


FIG. 6,758.—Circuit venting for a line of fixtures whose traps discharge into a common drain. ***It consists of*** an extension of the horizontal line of soil pipe and the connection of this extension into the main vent stack at a point *above* the fixture traps served by the extension. This thoroughly ventilates the extension and protects the traps against syphonage.

A method of venting called circuit venting is used to take care of a battery of fixtures discharging into a common drain line as shown in fig. 6,758.

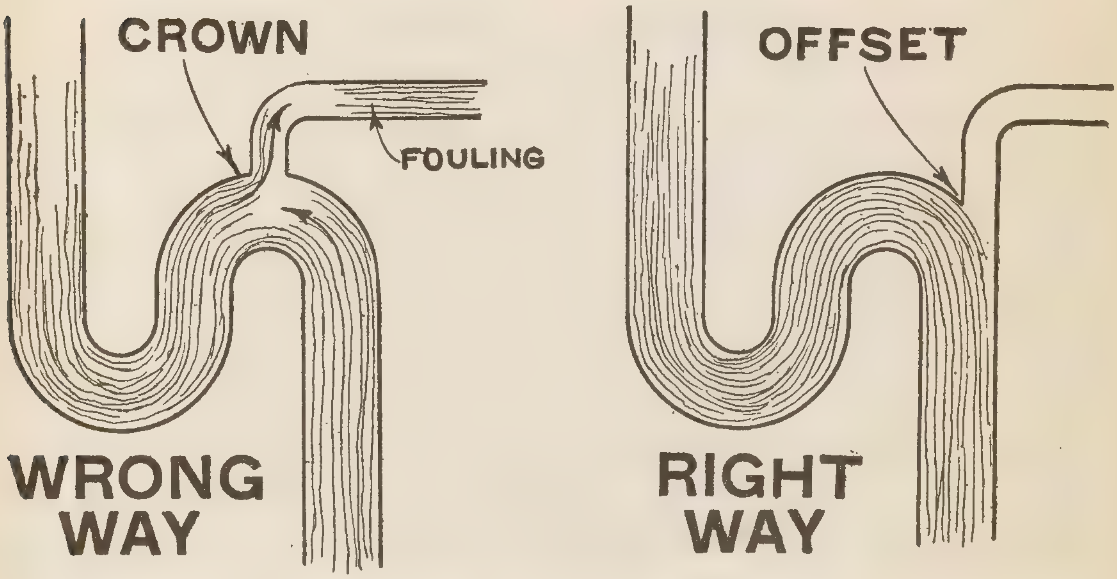
The circuit system is used chiefly for water closets. In this system the vent and soil stacks are usually at opposite ends of the line of closets. When both stacks are at the same end of the horizontal drain, the latter is extended as in circuit venting and then raised vertically to a point above the fixtures, then horizontally over the entire line and into the main vent. This is indicated by the dotted lines in fig. 6,758.



FIGS. 6,759 to 6,762.—Loop venting system showing operation. Fig. 6,759, discharge leaving trap, and syphonage broken by vent at A; fig. 6,760, discharge descending soil pipe pushing air current in front of it, and revolving in vent and soil stacks; fig. 6,761, discharge entering vent stack and house drain, air current not reversed in vent stack but checked as indicated by dotted arrows; fig. 6,762, discharge in house drain; normal upward fresh air current in vent stack admitted through fresh air inlet.

The loop method of venting is designed to avoid the tendency to "puffing" under the action of fixture discharge.

Instead, however, of reversing the general air circuit and drawing air from the roof to fill the void, the roof current in the vent stack from the loop connection up, is merely checked, more or less and the air already rising in the loop turns down the soil stack and fills the void.



Figs. 6,763 and 6,764.—Crown and offset connection of vent. In fig. 6,763 a sudden discharge of water will drive up into the vent carrying with it any foreign matter as grease, lin t, etc., tending to choke the vent, whereas with offset connection as in fig. 6,764, the current of water does not tend to enter the vent.

The action of the loop method of venting is shown progressively in figs. 6,759 to 6,762.

Fig. 6,759 shows the loop consisting of the main vent stack and a length of vertical soil pipe alongside, connected as shown.

With the loop system, when a discharge takes place from

the fixture, air is pushed in front of the discharge down the soil pipe with the same tendency to a vacuum behind the discharge.

CHAPTER 114

Elements of Sanitation

3. Sewage Disposal

By definition "sewage" *is the waste matter carried off in sewers; drainage water together with the solid refuse conveyed in it.*

The carrying off and disposal of sewage are the major problems in plumbing and the most important because upon the design and installation of that part of the plumbing which has to do with the sewage depends the health of the occupants of the building and frequently the community as well.

Having provided a proper drainage system for conveying sewage out of a building, it must be disposed of in some way such as will not endanger the health of those living in the vicinity.

There is a multiplicity of methods for sewage disposal, the choice being governed by local conditions, cost, etc. Broadly, sewage disposal includes:

1. Ejectment,
2. Distribution,
3. Purification.

Sewage may be ejected or conveyed from the building to the point where it is distributed or pumped either by:

1. Gravity, or
2. Mechanical means.

The most common method is the simple flow by gravity through an inclined sewer to the nearest river or body of water where distribution takes place, the sewage becoming so diluted by mixing with the large body of water that it is rendered harmless. This is shown in fig. 6,765. Where the house drain is below the sewer level, mechanical means is employed to elevate the sewage so it will flow into the sewer, as shown in fig. 6,766. This is common in large city buildings having sub-cellars.

Purification Methods.—In the absence of the natural method

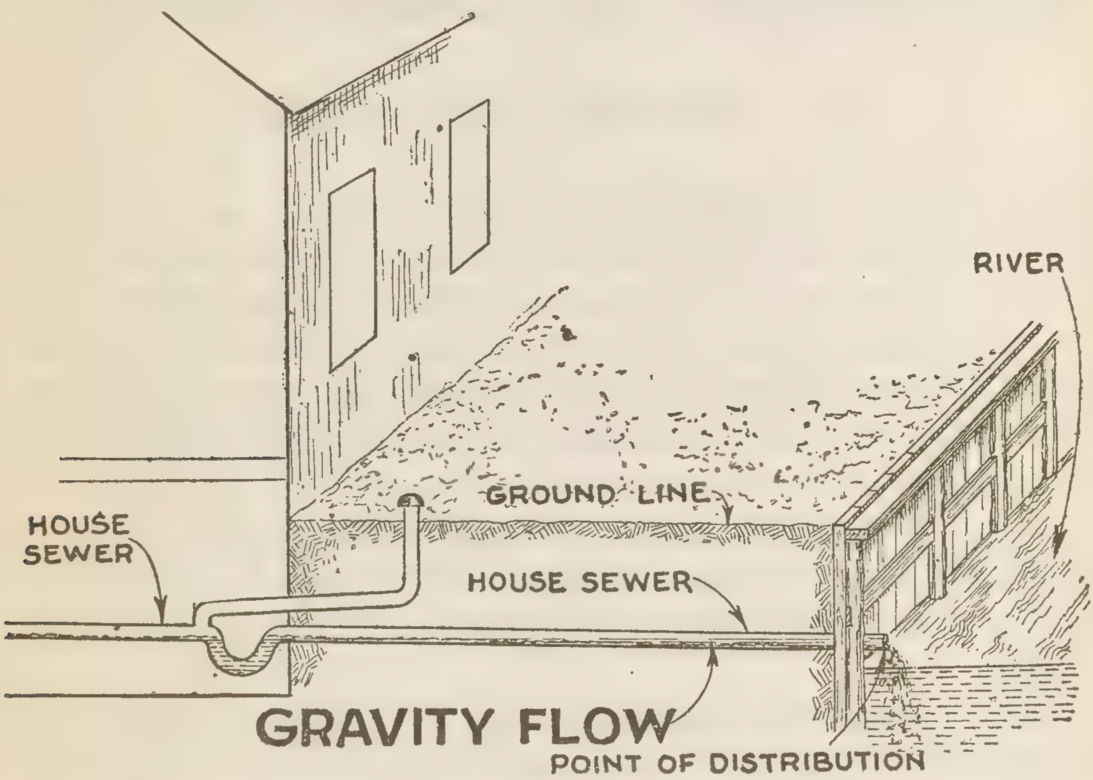


FIG. 6,765.—Ejectment of sewage by *gravity* as by inclined house sewer. ***The illustration*** also shows the distribution of sewage by mixing with a running stream. Here no attempt is made to purify the sewage before distribution. Such a method should not be employed unless the quantity of water available be proportionately very considerable. In fact, in some districts there are local ordinances against discharging sewage into rivers even when cesspools are employed.

of getting rid of sewage by public sewer emptying into a running stream or large body of water, various methods are employed to render the sewage harmless, as by the use of:

1. Cesspool.

   a. Leaching.
   b. Water tight.
   c. Combined tight and leaching.
2. Septic tank.
3. Mechanical filter.
4. Surface filtration (irrigation).
5. Sub-surface filtration.
   a. Filter bed.
   b. Absorption trench.

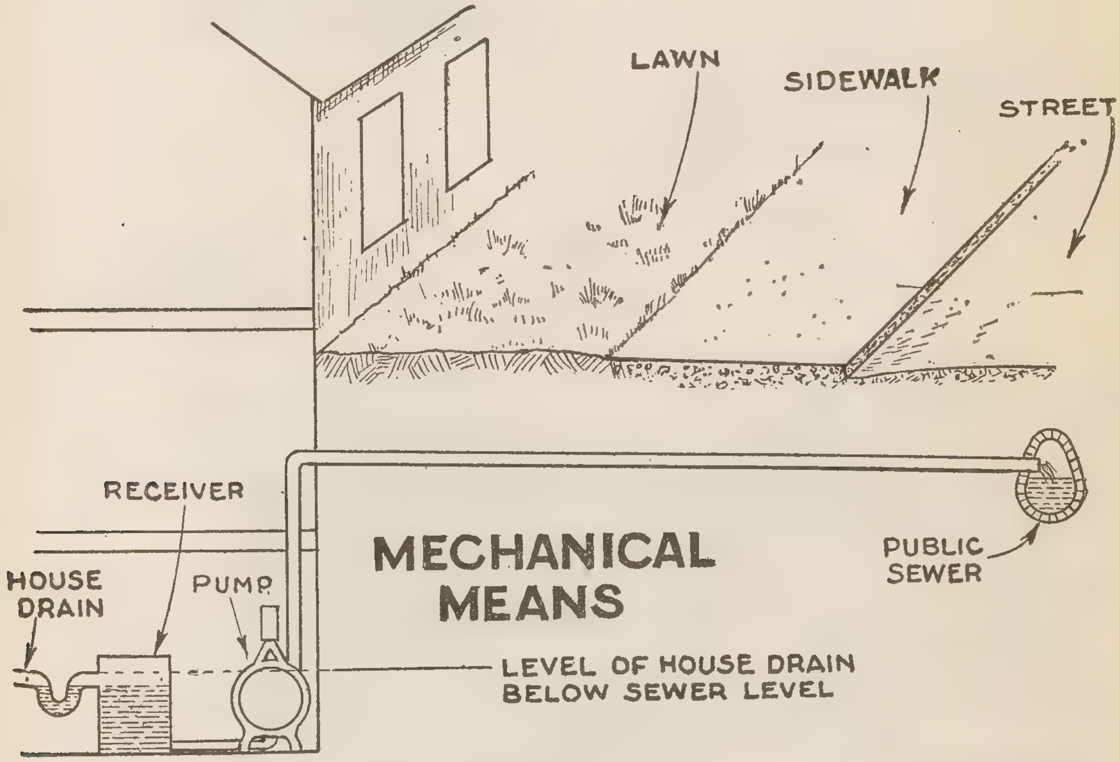


FIG. 6,766.—Ejectment of sewage by ***mechanical means.*** Evidently, where the house drain is below the level of the sewer or point of distribution, means must be provided for elevating the sewage to the level of the discharge point. ***In such case*** the house drain discharges into a receiver from which the sewage is elevated by a pump operated by a steam engine, electric motor or gas engine.

6. Chemical precipitation.

Cesspools.—By definition, a cesspool is *a covered pit for the reception of filth from drains, sinks, etc.*

A leaching cesspool is merely a hole in the ground, usually circular, and deeper than its diameter. The walls are generally of brick with dry joints, and the top is covered with a flag stone or other suitable covering, as shown in fig. 6,767. In operation

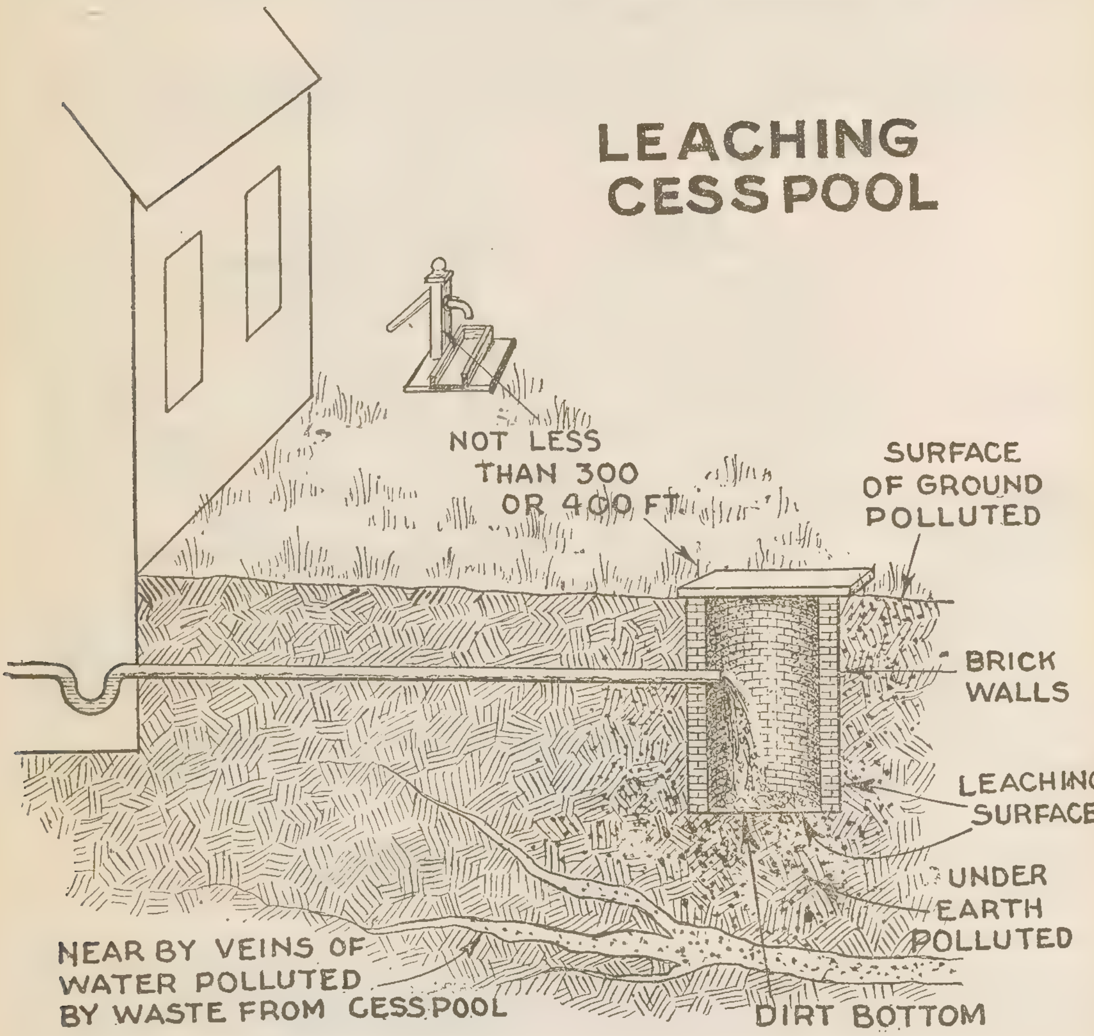


FIG. 6,767.—Leaching cesspool showing its inherent defects. This very unsatisfactory and dangerous method of sewage disposal should not be tolerated.

the sewage is discharged into the cesspool and the liquid part of it gradually seeps into the ground, the latter acting as a purifying agent so that after it has traversed a certain depth it becomes purified.

Cesspools are not sanitary and the waste will pollute and saturate the earth in the vicinity. This polluted matter will eventually come to the surface by soaking up through the ground, where it will decompose and evolve unwholesome and dangerous odors.

If the cesspool be near enough an underground vein of water it will render the water unfit for use. Accordingly where well water is used it is

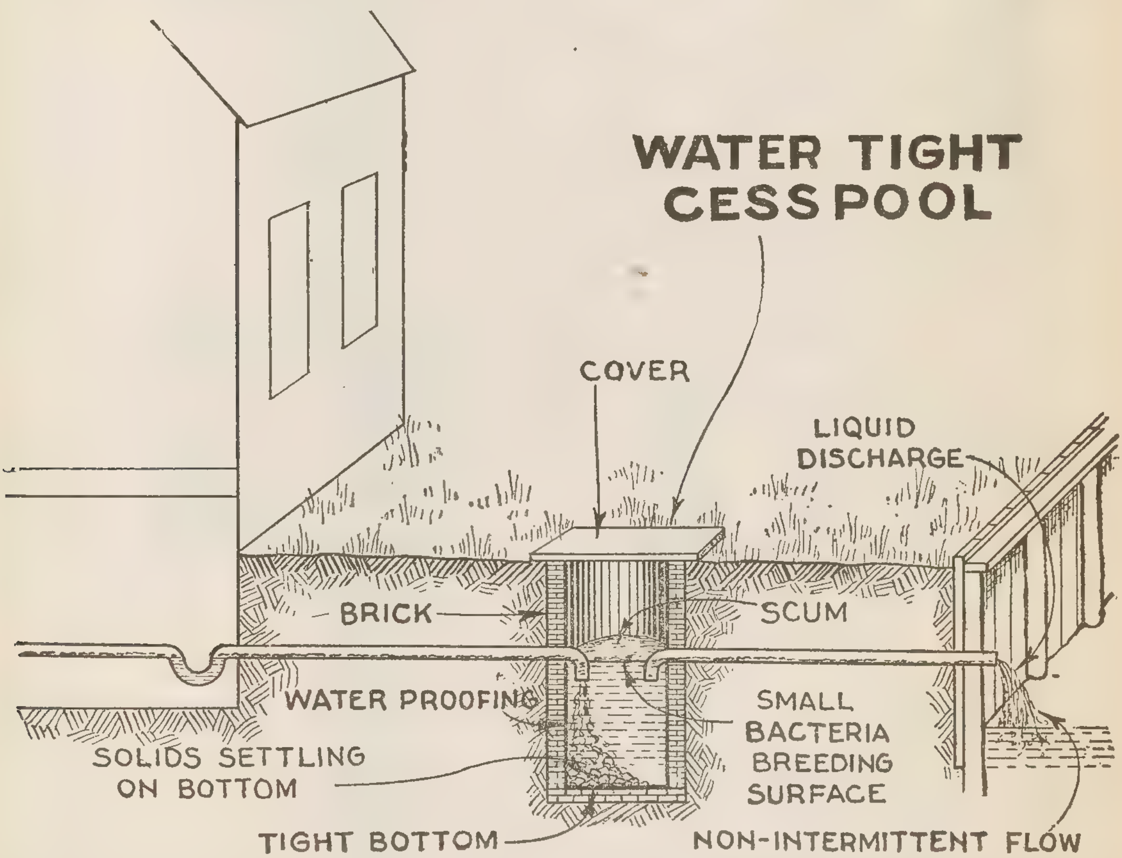


FIG. 6,768.—Water tight cesspools. ***In construction,*** the water proofing should be first class otherwise the poisonous liquid will seep through and pollute the ground as does the leaching cesspool. The water tight cesspool is suitable for installation where there is a safe and convenient point of distribution as discharge into a river, etc., but it requires frequent cleaning.

highly important to locate a cesspool as far away from the well as possible. The cesspool should be at least 300 or 400 feet distant from a well or spring located at a lower level than the cesspool. In the leaching cesspool there is practically no bacterial action to reduce solids to liquid, hence the solids must be removed from time to time. When located in a strata of gravel

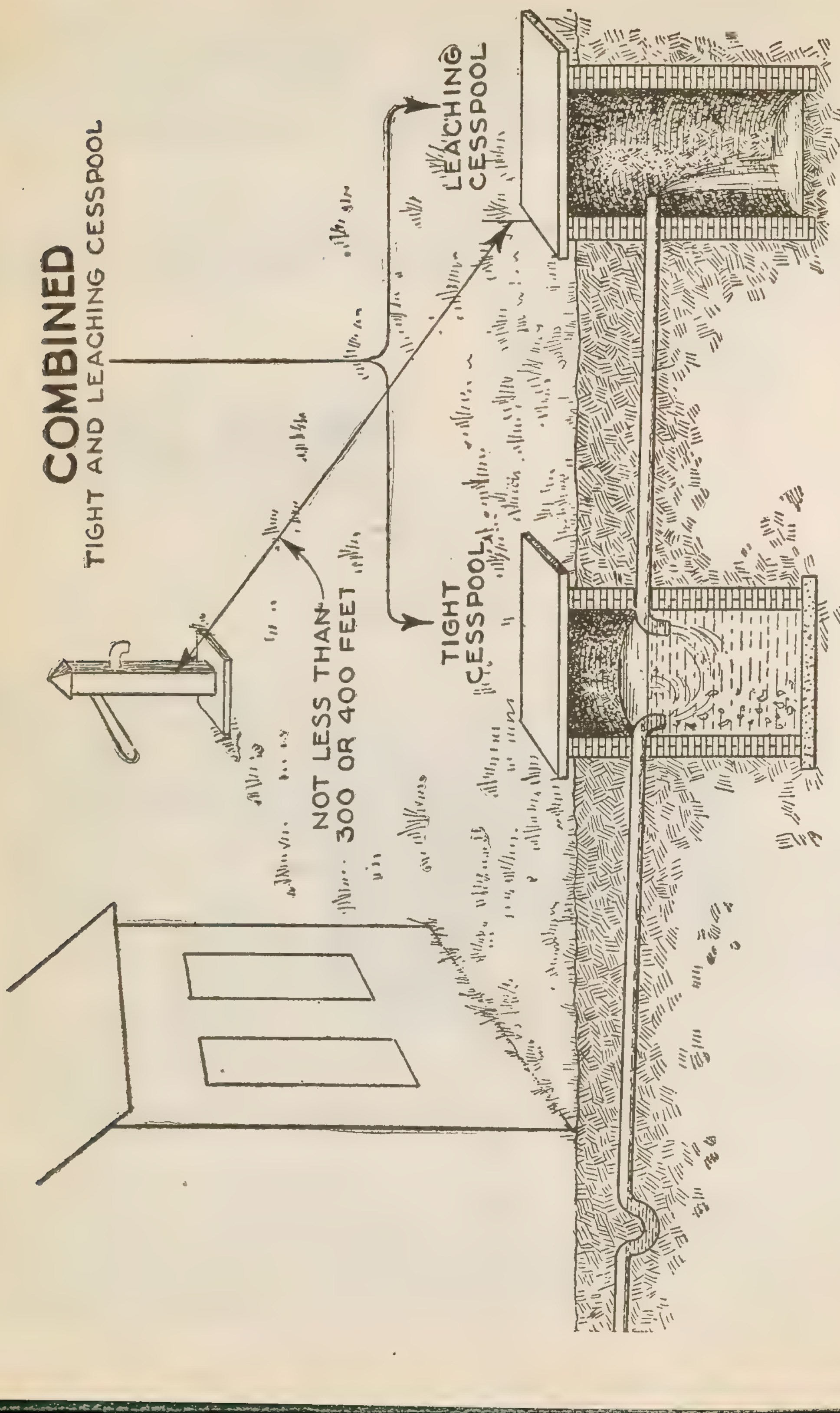


FIG. 6,769.—Combined tight and leaching cesspool. ***In this combination*** the raw sewage flows into the tight chamber where the solids settle to the bottom, the liquid flowing into a leaching chamber. Money spent on such an arrangement could better be invested in a septic tank, owing to inadequate leaching surface and unsanitary method of liquid disposal.

the leaching process is for awhile quite satisfactory; however, grease and soil in the waste soon closes the openings between the dry ground of the brick walls and chokes up the bottom leaching surface rendering the cesspool useless.

When the cesspool is located in clay or sandy soil leaching is very unsatisfactory and a considerably larger leaching surface should be provided.

A leaching cesspool is an unsatisfactory and unsanitary contrivance and should not be permitted under any circumstances.

A better arrangement is the tight cesspool, which is similar in construction to the leaching cesspool with exception that the bottom as well as walls is bricked and the entire interior surface coated with a waterproofing material so that no leaching action can take place. Where there is no suitable distribution point for the discharge of the liquid, the latter must be pumped off and properly disposed of when the cesspool is full.

In case of a running stream or other suitable distribution medium an outlet is provided and the liquid allowed to overflow as is fig. 6,768. Note here that the discharge is *non-intermittent*, that is, when the level of the openings is reached, inflow and discharge take place at the same time, hence the liquid is discharging almost continuously. This together with the small amount of bacteria breeding surface, are not favorable to much bacterial action, hence practically all the solids must be removed from time to time.

Septic Tanks.—By definition, the word *septic* means *any substance that produces or promotes putrefaction*, that is, *promotes the decomposition of animal or vegetable matter*, this process being now regarded as a kind of fermentation or breaking up of a complex organic compound into simpler compounds produced by micro organisms called *bacteria*.

It is upon the action of the bacteria that the operation of a septic tank depends; that is, *the septic tank takes the raw sewage that is delivered to it and reduces the solid matter contained in it to liquid form, with the exception of solids of a metallic or mineral nature*.

The raw sewage which enters the tank already contains millions of bacteria, which attack the solids carried into the tank with the liquid.

The object of the tank is 1, to provide a storage place where the motion of the liquid is arrested so as to give sufficient opportunity for the bacteria to reduce nearly all solids, which they are able to attack to liquid form, and 2, to provide a breeding place to increase the number of bacteria so as to accelerate the decomposition of the solids. The bacteria act strongly on the vegetable and animal solids, but cannot act on metal or mineral substances; this part of the sewage settles to the bottom of the tank in the form of sludge and should be removed from time to time.

The bacteria begin their attack on the solids which settle to the bottom of the tank. During this process gas is generated and as the gas passes to the top of the liquid it carries up with it particles of the solid matter which collect at the surface of the tank forming eventually, a think scum. This forms a breeding place for bacteria thus augmenting the attacking force. Accordingly there should be a larger surface for scum to form than is provided in a cesspool to obtain maximum breeding of bacteria.

For favorable breeding conditions the scum should remain as undisturbed as possible, and all light and air should be excluded.

The sewage should remain in the tank long enough (about 24 hours) for the completion of the bacterial attack, that is for the reduction of all the reducible solids to liquids.

In order to meet the foregoing requirements in practice, the construction of a septic tank should provide:

1. A settling chamber.

To hold a practicably undisturbed body of sewage allowing the solids to sink to the bottom where they are attacked and providing a scum surface for the breeding of bacteria.

2. Baffle boards, or turn down elbows at inlet and outlet of settling chamber.

To prevent disturbance of scum by inflow and outflow of settling chamber.

3. Discharge or syphon chamber.

To prevent disturbance of scum by variation in level during discharge and refill periods.

4. Bell syphon.

To secure intermittent discharge.

5. Cover.

For protection and to exclude air and light, the condition favorable for the maximum breeding of bacteria.

Fig. 6,772 shows a septic tank which has these essential features.

The settling and syphon chambers are here shown separated by a short length of pipe to emphasize these two distinct elements. They are sometimes built this way and sometimes together, the latter being a cheaper

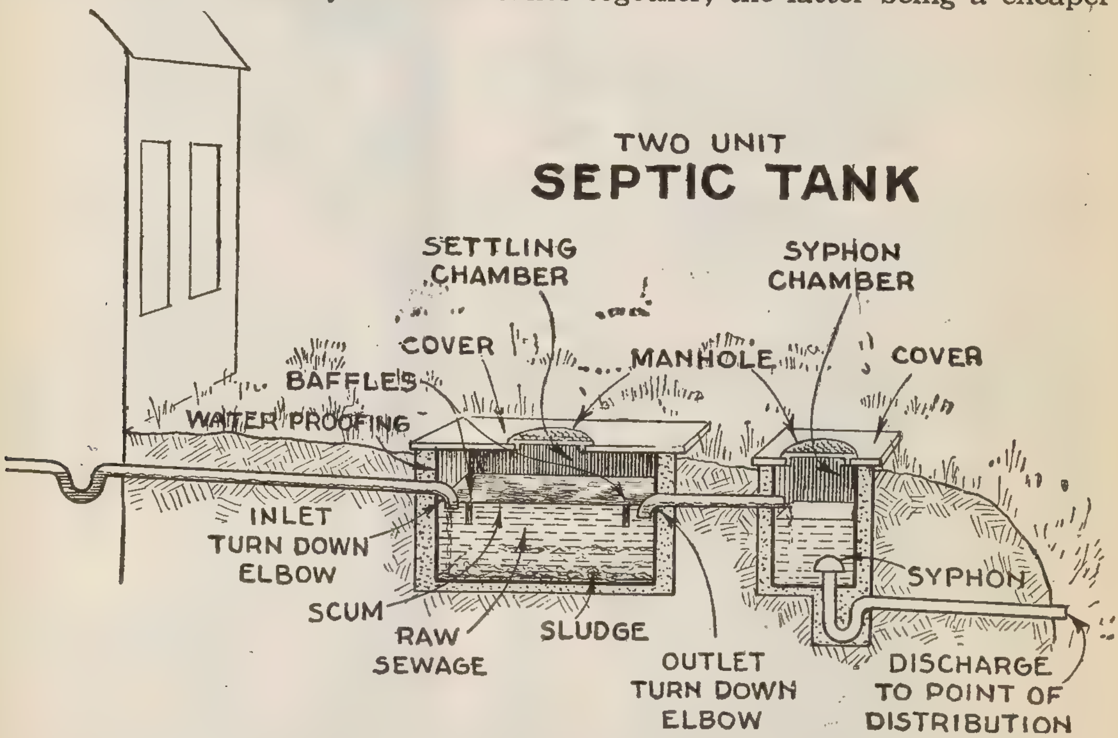
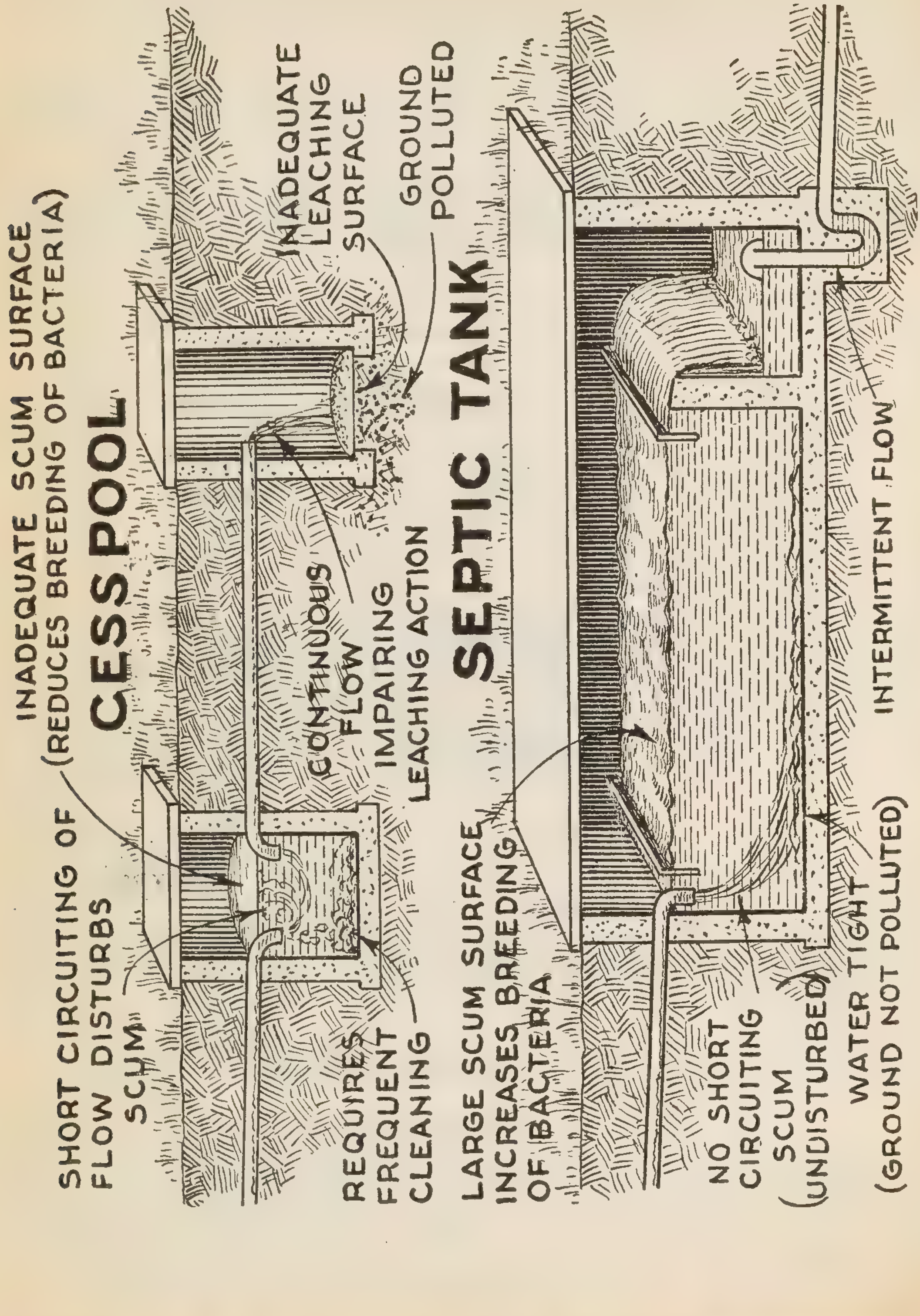


Fig. 6,770.—Two unit septic tank, consisting of settling and syphon water tight chambers. This is an approved method of reducing almost all the solids in raw sewage to liquids to facilitate disposal. It should be understood that the bacterial attack (described in the text) which takes place in the settling chamber does not purify the liquid, hence the safety of the system depends upon the method of disposing of the liquid.

construction, as in this case it is virtually a single chamber with two compartments having a spillway wall intervening as shown in fig. 6,773.

A careful distinction should be made between a cesspool and a septic tank. The comparison shown in figs. 6,771 and 6,772 shows the defects of the former and the desirable features of the latter



Figs. 6,771 and 6,772.—Comparison ofcombined tight and leaching cesspool and septic tank showing advantages of the latter.

Since from the construction indicated in the illustration it is seen that the cesspool costs about as much as the septic tank, preference should be given to the latter; of course, an additional outlay is necessary with the septic tank for disposal of the liquid in amounts depending upon the method of disposal, however any extra expense is more than offset by the advantages of the septic tank.

An important feature of a septic tank is the intermittent flow secured by means of a syphon.

This is important because it has been found by experience that if sewage be discharged constantly into a filtering area, this area will eventually

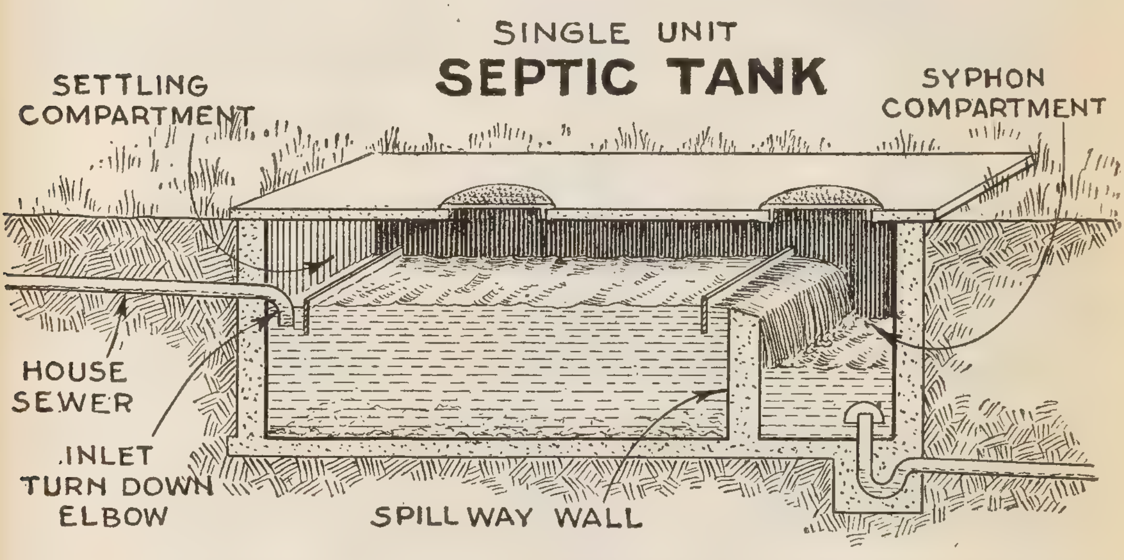
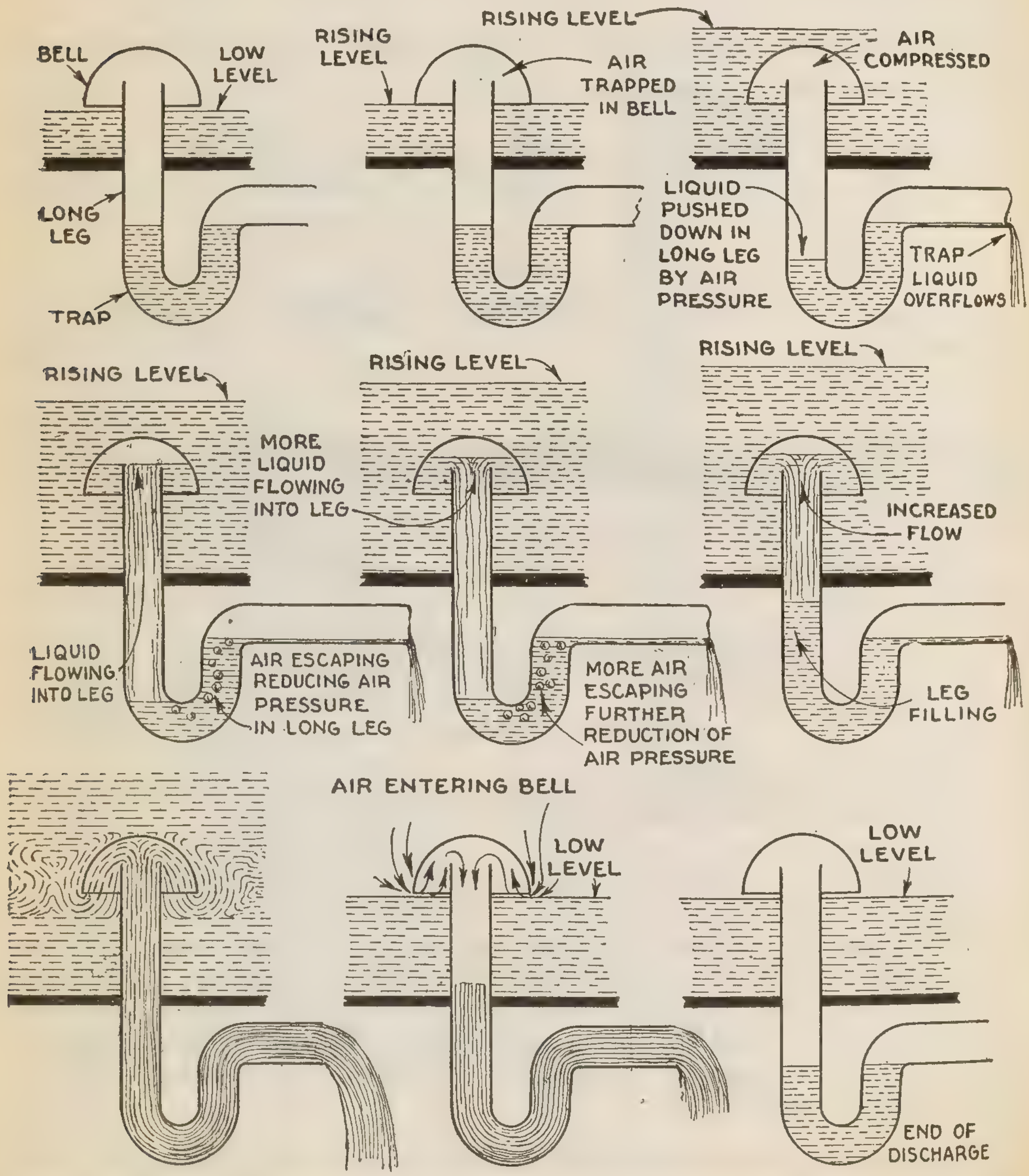


FIG. 6,773.—Single unit septic tank. This is virtually the same as the double unit type, the chambers being joined together with only a spillway wall intervening.

become fouled or clogged, rendering it incapable of performing its work, whereas if the flow be intermittent, so that a new supply of air could penetrate through the filtering area before another charge of sewage is delivered, the purification due to the leaching action can be continued indefinitely. Moreover a slow continuous discharge does not give equal distribution over the filtering area as in the case of a periodic flush, hence some parts of the filtering area are overworked while others are idle resulting in unsatisfactory operation.

To obtain an intermittent flow, the bell type syphon is generally used, the operation of which is shown progressively in figs. 6,774 to 6,782.

Final Stage of Sewage Disposal.—The duty performed by a septic tank is principally *the reduction of the solid matter originally contained in the raw sewage.* This operation, however, is important, as without it further purification would



FIGS. 6,774 to 6,782.—Operation of septic tank intermittent bell syphon shown progressively.

be a difficult matter. The discharge from a septic tank contains much organic matter in solution, which must be changed into oxides and nitrogen compounds, and this final process of purification depends upon the action of an entirely different class of bacteria than those which breed in the septic tank.

The bacteria necessary for the final stage of purification are

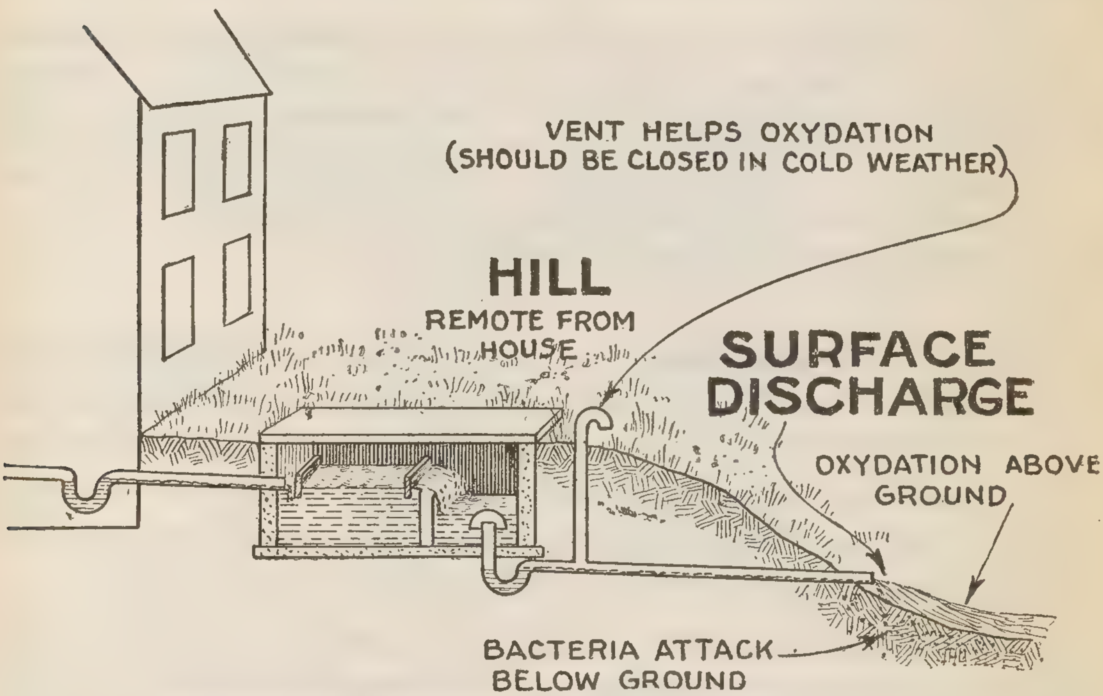


FIG. 6,783.—Surface discharge from septic tank. ***Purification of sewage after discharge*** due to oxidation above surface of the ground and bacterial attack below surface of the ground. ***Condition of tolerance:*** a hill to secure distribution, sufficiently remote from house, porous soil permitting percolation to secure bacterial attack.

to be found near the surface of the earth, hence usually surface, or sub-surface, systems are employed.

Surface Filtration.—This consists of discharging sewage from septic tank on the surface of the ground. This is a questionable method of final disposal and should only be resorted to where a suitable place is available as permitting the

discharge to flow down the side of a hill of suitably porous soil sufficiently far from any building as not to be objectionable. The sewage flowing over the surface of the ground will be subject to an oxidizing action due to contact with the air and to aid the oxidizing action in purifying the sewage there should be a vent near the septic tank, ventilating the sewer and bringing air in contact with the sewage as it flows through the sewer.

In very cold weather this vent may do more harm than good by chilling the liquid, accordingly it should be provided with a cap or equivalent means of closing it in cold weather. This system of surface filtration is shown in fig. 6,783. The oxidation due to contact with the air does not completely purify the sewage, the final stage of purification taking place as the liquid percolates into the ground, there being attacked by the bacteria found near the surface of the ground.

Sub-Surface Filtration.—In this system the sewage from the septic tank is finally disposed of by discharge below the surface of the ground where it is subject at once to bacterial attack in its final stage of purification. Success of the system depends on the nature of the soil with respect to its ability to absorb the liquid discharged.

Evidently such system is only employed on a small scale, chiefly for private dwellings. Numerous methods are employed in the proper distribution of the liquid sewage over the sub-soil filtration area, as described in the sections following.

Mechanical Filter Dry Well.—This is a form of leaching basin for the final disposal of sewage from a septic tank, designed to arrest any solids that may be carried over in the discharge from the septic tank so that the efficiency of the limited leaching surface is increased. It is usually constructed the same as an ordinary leaching cesspool that is bricked up with open joints and earth bottom.

Two or more vertical lines of tile, inverted Ys, are provided and the well filled with crushed stone to secure the filtering action. A distribution cone is placed on the end of the sewer discharge pipe as shown in fig. 6,784.

In the intermittent discharge into the well from the septic tank evidently as the sewage percolates through the crushed stone, the latter will intercept the solids, allowing the liquid

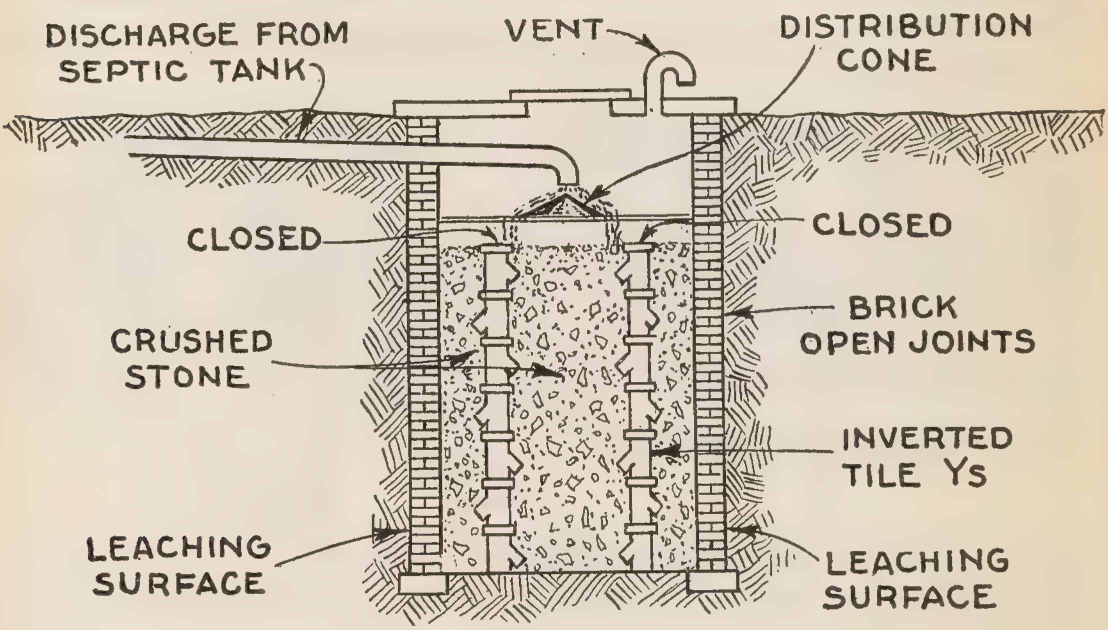


FIG. 6,784.—Mechanical filter dry well designed to eliminate solids from the sewage before the liquid reaches the leaching surface.

to gravitate to the bottom and through the walls; thus only clear liquid comes in contact with the earth.

There should be a large vent, to provide an adequate supply of air which is necessary for the satisfactory working of the filter.

Absorption Trench.—This is virtually a horizontal dry well in which the sewage is distributed over the crushed stone filling by means of tile pipe with open joints, as shown in

fig. 6,785. Evidently more leaching surface is easily obtainable than with the dry well, and located nearer the surface of the ground a stronger bacterial attack results as the bacteria are found near the surface. The trench is suitable where there is sand or gravel at the surface and clay below. The air vent is important for reasons already mentioned.

Filter Bed.—In this method of final disposal, *the sewage is distributed over a considerable sub-soil area by means of numerous*

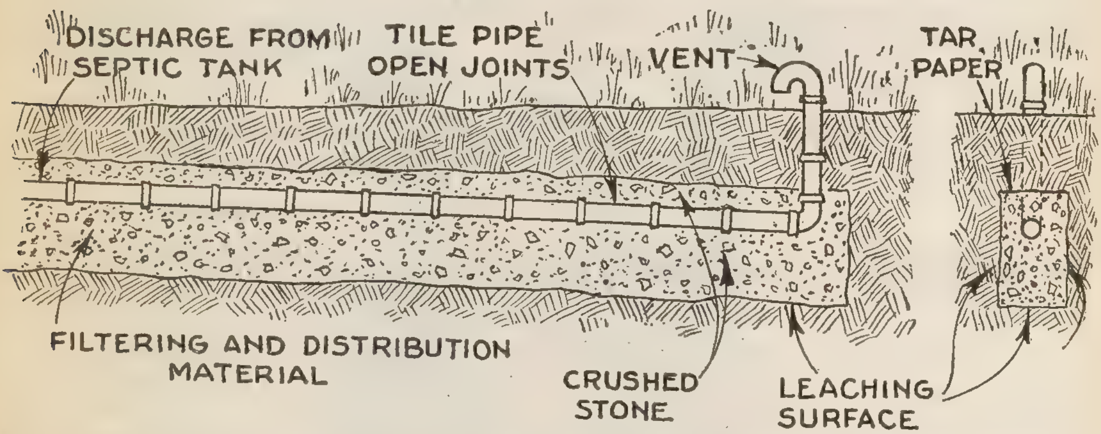


FIG. 6,785.—Absorption trench showing tile pipe with open distribution joints, crushed stone filter, and extended leaching surface (as compared with a cesspool or dry well) due to length of trench, also vent to supply air for oxidizing action necessary for the proper operation of the filter.

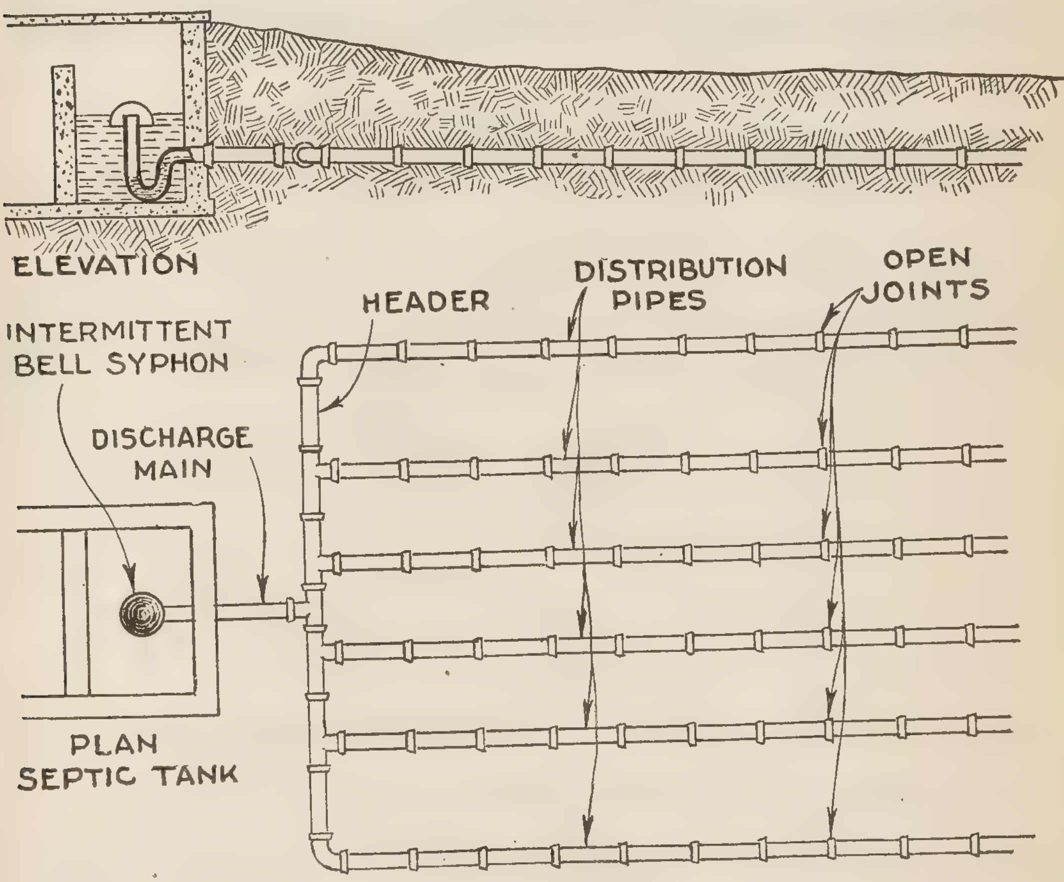
parallel lines of tile laid open joint and connected to a header which in turn is connected to the discharge line from the septic tank, as shown in figs. 6,786 and 6,787.

As distinguished from the absorption trench, the pipe is in contact with the earth instead of being embedded in crushed stone. The pipe should be laid as near the surface of the earth as practicable because the number of bacteria are greater near the surface, gradually decreasing in number with increasing depth and not found at a greater depth than five feet.

The next favorable soils for the breeding of bacteria are sandy soils, because oxygen penetrates easier than in the heavier soils. The effect of the sewage discharge is to cause each particle of the soil to become coated with a microscopic gelatine in which the bacteria live and breed. Now these

bacteria attack the sewage as it filters down, gathering the impure organic matter contained in the sewage and after it drains through, oxygen penetrates to the bacteria and reduces the organic matter to harmless elements. This happens during the period of intermission between discharging of the syphon, hence an intermittent flow is necessary for proper operation.

Chemical Precipitation.—By the addition of certain chemicals to the sewage, chemical action is set up which greatly in-



FIGS. 6,786 and 6,787.—Filter bed showing parallel connection of a number of tile pipe lines with open joint, thus distributing the discharge over a large area.

creases the rapidity with which precipitation takes place. The best chemical to use depends upon the sewage and local conditions. The chemical should be added to the sewage and thoroughly mixed before it reaches the settling tank. This may

be effected by the use of projection or baffling plates placed in the conduit leading to the tank. The most useful chemicals are lime, sulphate of alumina and some of the salts of iron. Long, narrow tanks should be operated on the continuous rather than the intermittent plan.

CHAPTER 115

Soil Pipe and Pipe Joints

Before taking up "roughing-in" work, the plumbing student should know something about soil pipe and the large variety of fittings used; he should have a thorough knowledge of the joints, how they are made up and the reason for using certain fittings, etc. There are two kinds of soil pipe used for drainage work, classified according to the kind of joint and material, as:

1. Bell and spigot cast iron pipe.

   a. Plain.
   b. Coated.
   c. Lined.
   d. Standard weight.
   e. Extra heavy.

2. Wrought pipe, threaded.

   (Cast or malleable iron recessed threaded fittings; Durham system.)

The thickness of cast iron pipe for any given size varies according to class as 1 *standard*, 2 *medium*, 3 *extra heavy*.

The weight known as standard is sometimes used on buildings under four stories in height, and for vent pipe and soil pipe extensions above the highest fixture.

Extra heavy pipe and fittings are used in tall buildings and in most ordinary work for all soil and waste purposes below the highest fixture. The standard length of cast soil pipe for all sizes is five feet, exclusive of bell.

The following table gives weight for various sizes of soil pipe.

Average Weight of Cast Iron Pipe

(According to Abendroth)

Diam. in ins.	2	3	4	5	6	8	10	12	15
	Weight in lbs. per 5 ft. length								
Standard..........	17½	22½	32½	42½	52½	85	115	165	225
Extra heavy........	27½	47½	65	85	100	170	225	270	375

Bell and spigot cast iron pipe is generally conceded as the best pipe for drainage work; the other kind in the opinion of the author should never be used, because wrought pipe has a much shorter life than cast iron pipe and the joint although recessed, tends to collect paper and other foreign matter more so than does the bell and spigot joint because of the burrs left on the ends of wrought pipe when cut and not reamed out.

Another objection is that in installing the pipe, it must be in perfect alignment, otherwise the pipe cannot be screwed into the fitting or vice versa; whereas the bell and spigot joint presents no such difficulty and the work accordingly does not have to be performed with the same degree of precision.

Bell and Spigot Joints.—A line of pipe is composed of numerous lengths of pipes or units which must be connected by some form of joint so that the junctions will be water and air tight. In the case of cast iron soil pipe the bell and spigot form of joint is used.

NOTE.—***The grades of cast iron soil pipe*** mostly used are ***standard*** and ***extra heavy.*** On best work extra heavy pipe is used because it will stand more caulking and consequently a tighter and stronger joint can be made. It has greater strength to support a long line of pipe and is more durable because of its extra thickness. It is easier to cut extra heavy pipe with a hammer and cold chisel than light pipe ***A medium weight*** pipe is obtainable from some foundries.

In this joint each piece is made with an enlarged *hub* or *bell* at one end into which the plain or spigot end of another piece is inserted when laying. The joint is then made tight by cement, oakum, lead, rubber or other suitable substance which is driven in or calked into the bell and around the spigot. When a similar joint is made in wrought pipe by means of a cast bell (or hub) it is at times called hub and spigot joint (poor usage).

Fig. 6,788, shows the bell and spigot ends of two lengths of pipe telescoped or in position for packing so it will not leak.

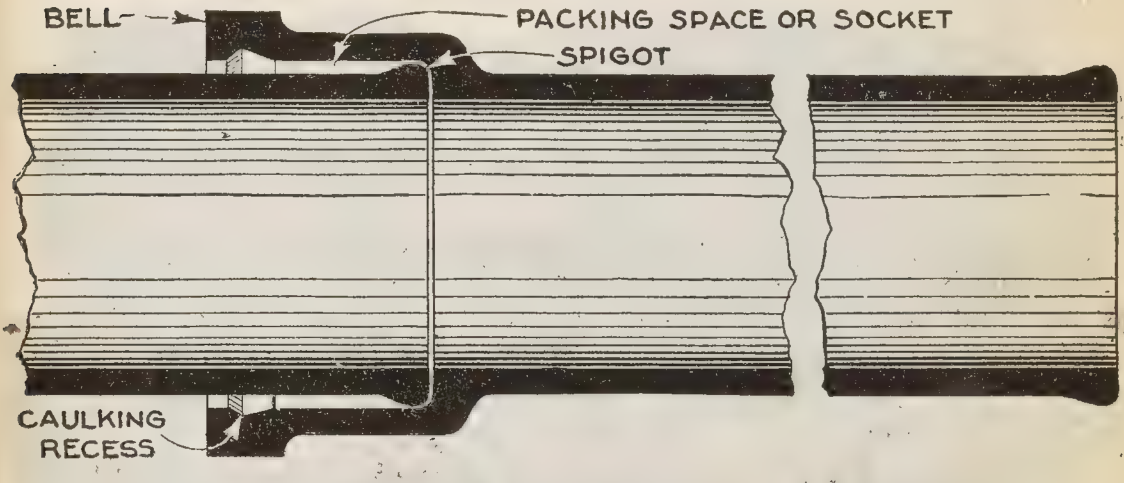


FIG. 6,788.—Bell and spigot joint as used for connecting lengths of cast iron soil pipe.

In making up the joint two materials are required:

1. Oakum.
2. Lead.

Oakum is *shredded rope or hemp fibre* and should be of the best quality. It usually comes in 50-lb. bales as shown in fig. 6,789. Some plumbers think that old scrap lead will answer, but this is a mistake because soft lead should be used for reasons later given.

Making up the joint consists of three operations:

1. Packing the oakum.
2. Pouring the molten lead.
3. Caulking the lead.

Packing the Oakum.—The pipes being placed in the telescoped position shown in fig. 6,788, the plumber first caulks twisted or spun oakum into the annular packing space or socket, similarly to packing a stuffing box on an engine, working it around and then driving it in tightly with a yarning iron and hammer, as shown in fig. 6,790.

The socket should be packed at least half full of the oakum. A good

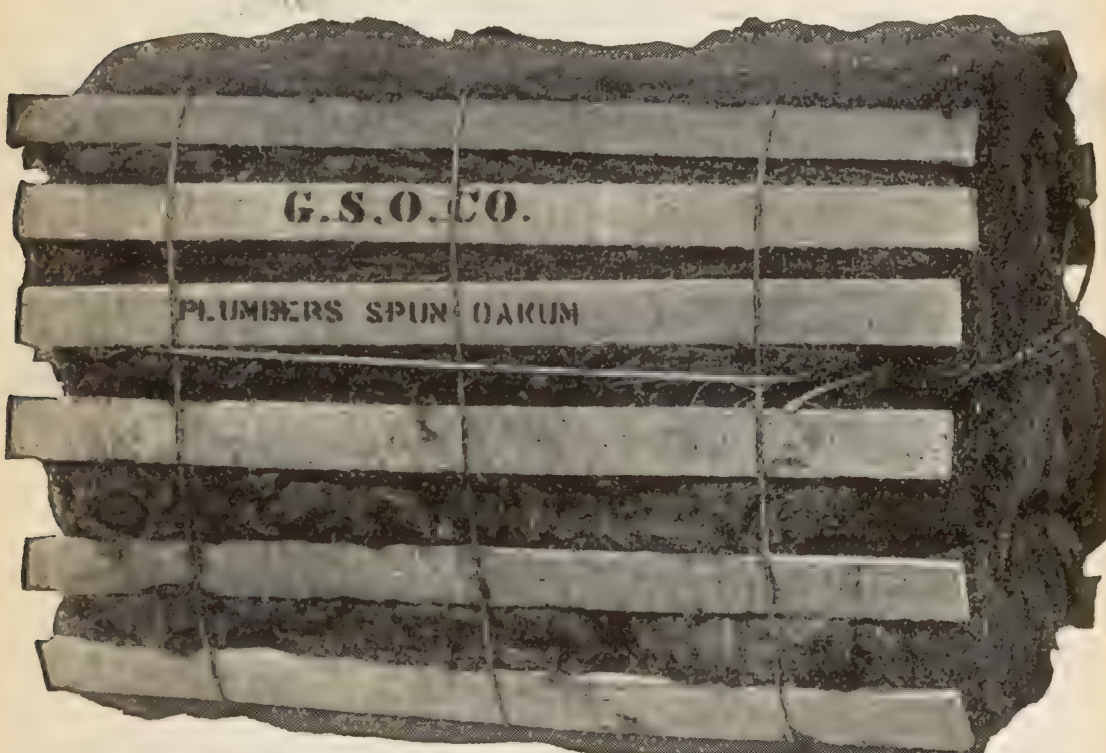


FIG. 6,789.—Plumber's spun oakum as usually put up in 50 lb. bales.

quantity of oakum packed tightly and a less quantity of lead makes the best job.

The oakum must be thoroughly compressed so as to make a solid bed for the lead. Oakum even without lead can often be made to hold a heavy pressure of water.

Figs. 6,791 and 6,792 show two patterns of yarning iron used in compressing the oakum. Special irons are needed to reach close places as where the pipe is laid close to the corner of a wall as in fig. 6,793. Numerous

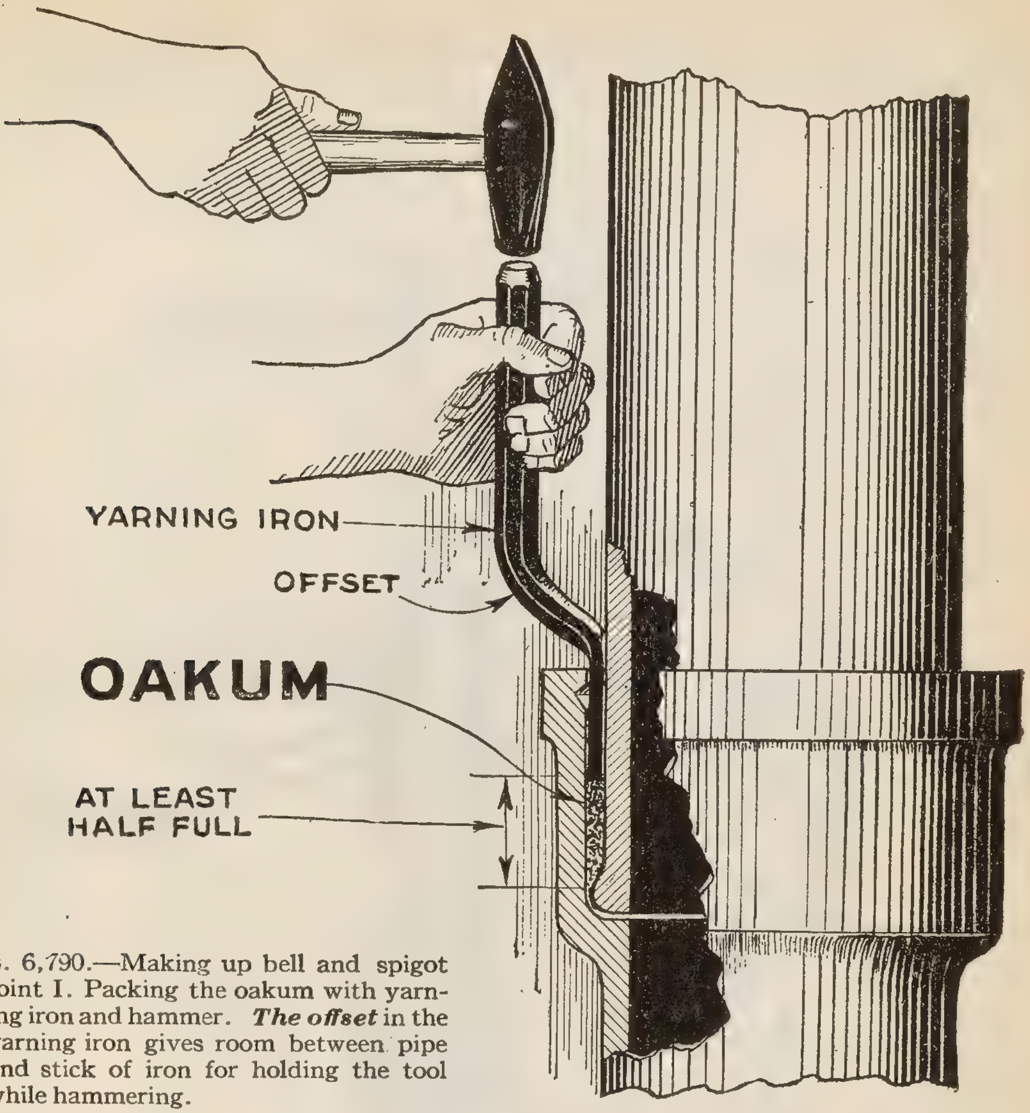
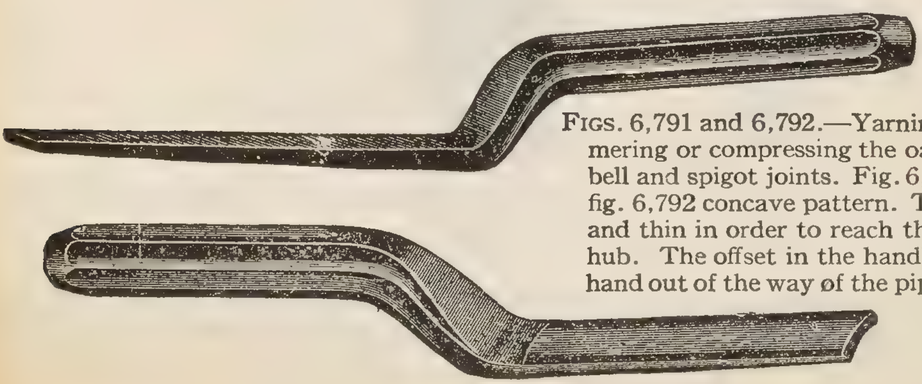


FIG. 6,790.—Making up bell and spigot joint I. Packing the oakum with yarning iron and hammer. ***The offset*** in the yarning iron gives room between pipe and stick of iron for holding the tool while hammering.



FIGS. 6,791 and 6,792.—Yarning irons for hammering or compressing the oakum packing in bell and spigot joints. Fig. 6,791 flat pattern; fig. 6,792 concave pattern. The blade is long and thin in order to reach the bottom of the hub. The offset in the handle is to keep the hand out of the way of the pipe when using it.

cases of close work occur, there being a multiplicity of tool shapes to meet all conditions. Some special tools generally used being shown in figs. 6,794 to 6,801.

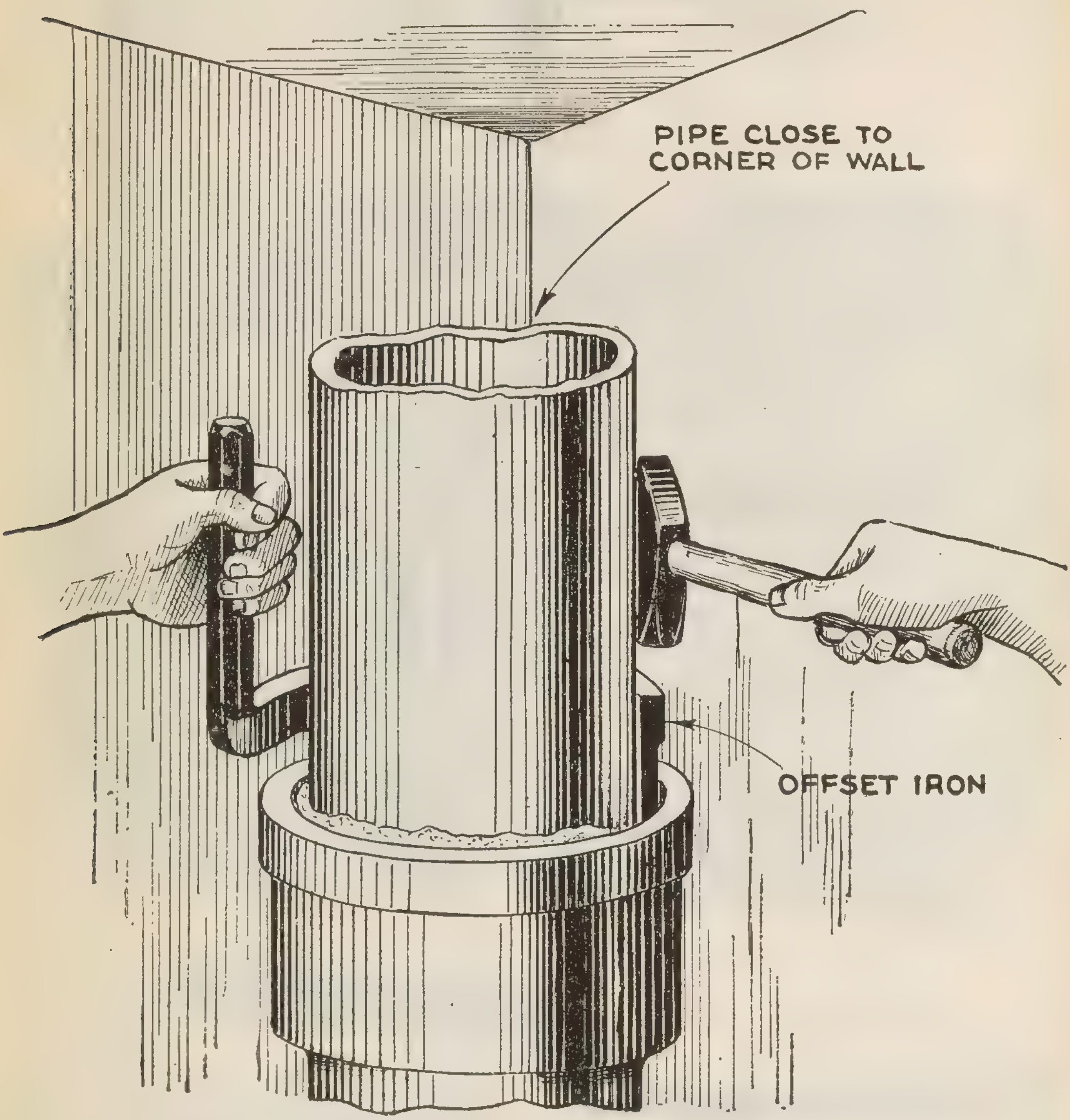
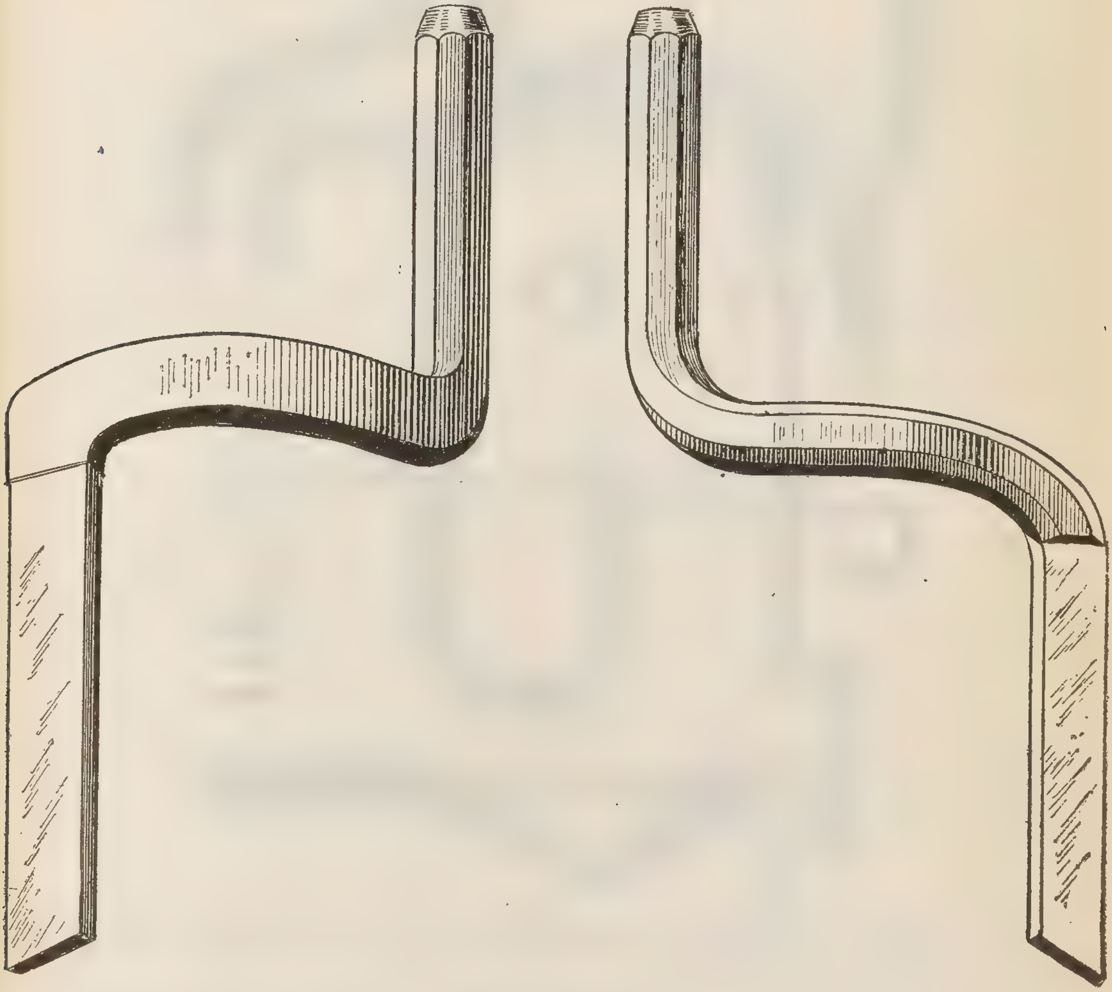


FIG. 6,793.—Offset yarning iron for packing oakum in joint where pipe is close to wall.

In this connection it should be noted that yarning or caulking irons with hammer combined in one tool can be obtained as shown in figs. 6,802 to 6,805.

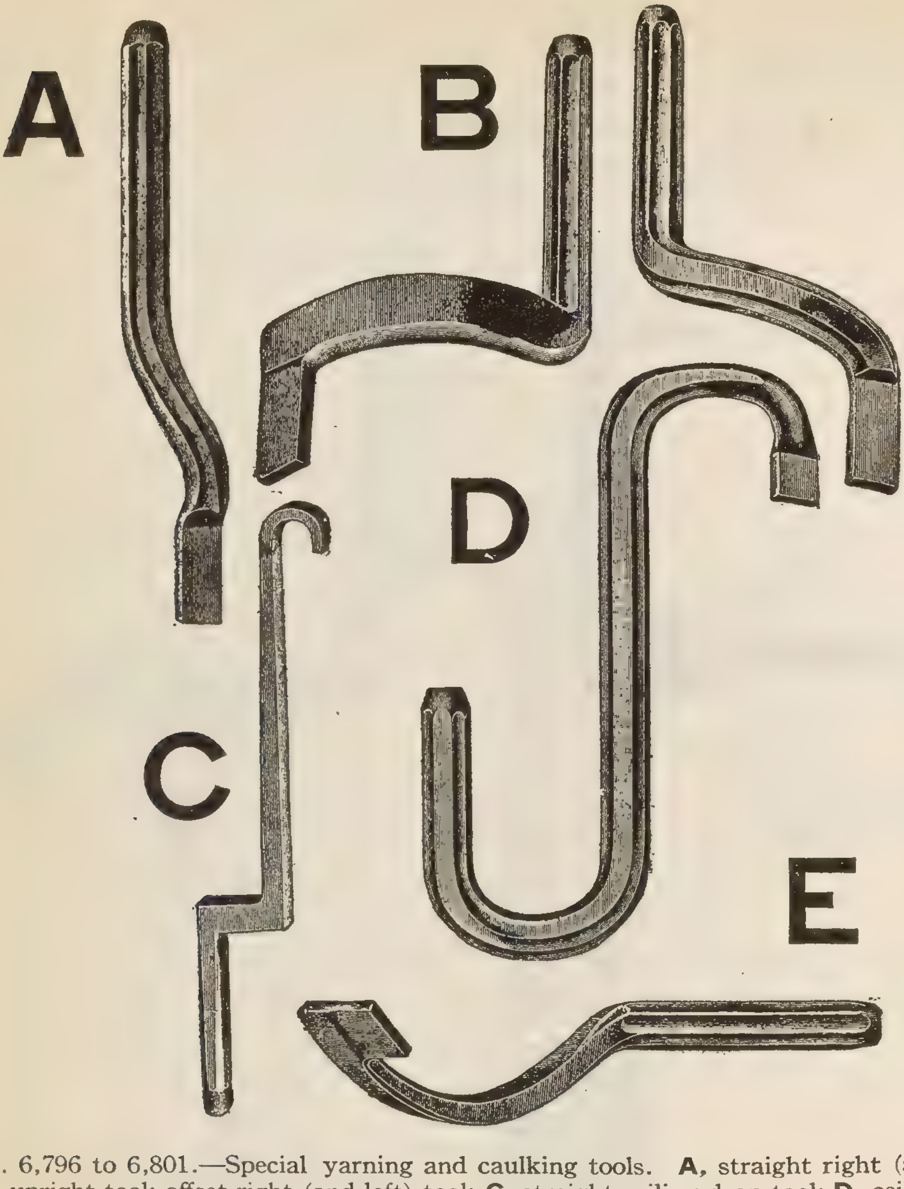
For joints near the ceiling it is necessary to use a ceiling drop tool to pack the socket as shown in fig. 6,799. The handle of this tool is quite heavy, so that the yarn may be first forced into the socket by a series of jerking blows with the



FIGS. 6,794 and 6,795.—Right and left upright yarning tools.

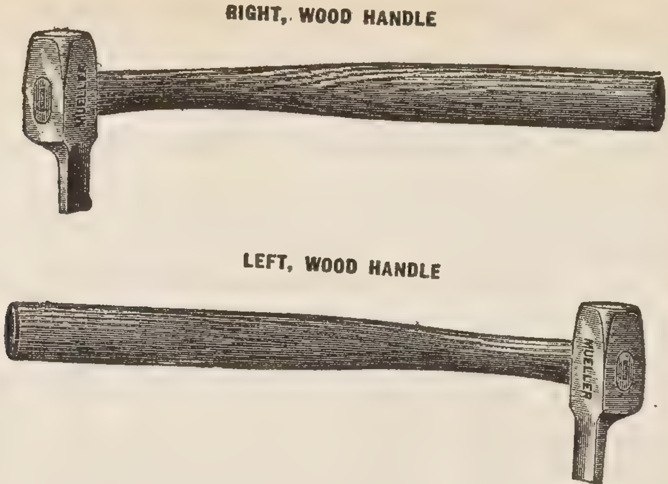
hand as in fig. 6,807. The offset at the handle provides a surface for blows with a hammer in packing the yarn tightly in the socket, as in fig. 6,808.

The following table shows the amount of oakum and lead for making up joints on various size soil pipes:

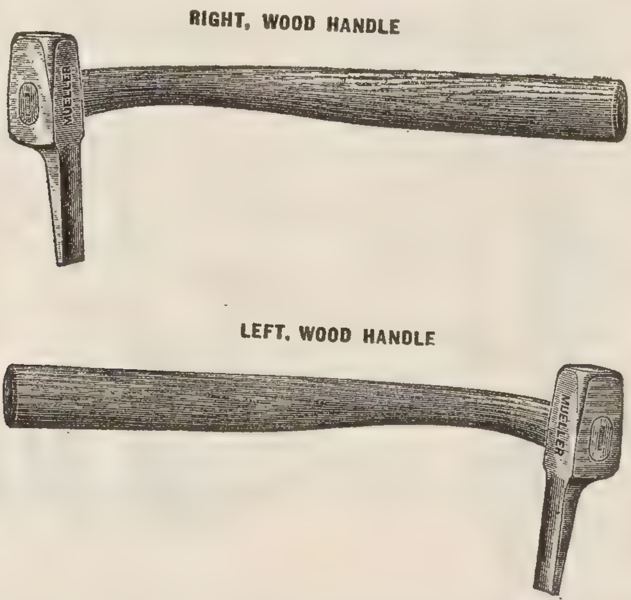


FIGS. 6,796 to 6,801.—Special yarning and caulking tools. **A,** straight right (and left tool; **B,** upright tool; offset right (and left) tool; **C,** straight ceiling drop tool; **D,** ceiling drop "S" tool; **E,** right angle (right and left) tool.

NOTE.—***A first class mechanic*** will lose a great deal of his producing effect with inferior tools, and perhaps spoil costly jobs. Caulking tools should be made from the best grade of tool steel. There is a very great multiplicity of shapes of yarning and caulking tools available, designed to reach every conceivable inaccessible position. ***It is accordingly inexcusable*** for a plumber to attempt a caulking job without the correct shapes, because such practice only results in unnecessary time and a botch job with accompanying extra expense and questionable tightness of joints. An honest workman will accordingly not only possess the proper tools but will not "forget" (?) to take them with him when starting for the job.



FIGS. 6,802 and 6,803.—Combined caulking irons and hammers, with wood handles. Fig. 6,802, left; fig. 6,803, right.



FIGS. 6,804 and 6,805.—Combined yarning irons and hammers. Fig. 6,804, left; fig. 6,805, right.

NOTE.—***In small size pipes,*** the strain from handling sections "made up" before placing in permanent position is more in the line of compressing the lead and splitting the hub. With the larger sizes, any strain tending to throw the lengths out of alignment does more toward stripping the joint out of the hub. Two and 4 in. diameter, need as great depth of hub as the larger sizes, not only for general strength, thickness and permanence of alignment in place, but because these sizes are more often handled "made up." Large sizes are put in place before any joints are made up and are usually placed so as to be almost independent of joints, so far as support is concerned.—*Gray.*

Oakum and Lead for Caulked Joint

Material	Size of Pipe							
	2	3	4	5	6	7	8	10
Oakum......... (Ft. reqd.)......	3	4½	5	6½	7½	8½	9½	12
Lead........... (lbs. reqd.).....	1½	2¼	3	3¾	4½	5¼	6	7½

Pouring the Molten Lead.—When the yarn has been tightly

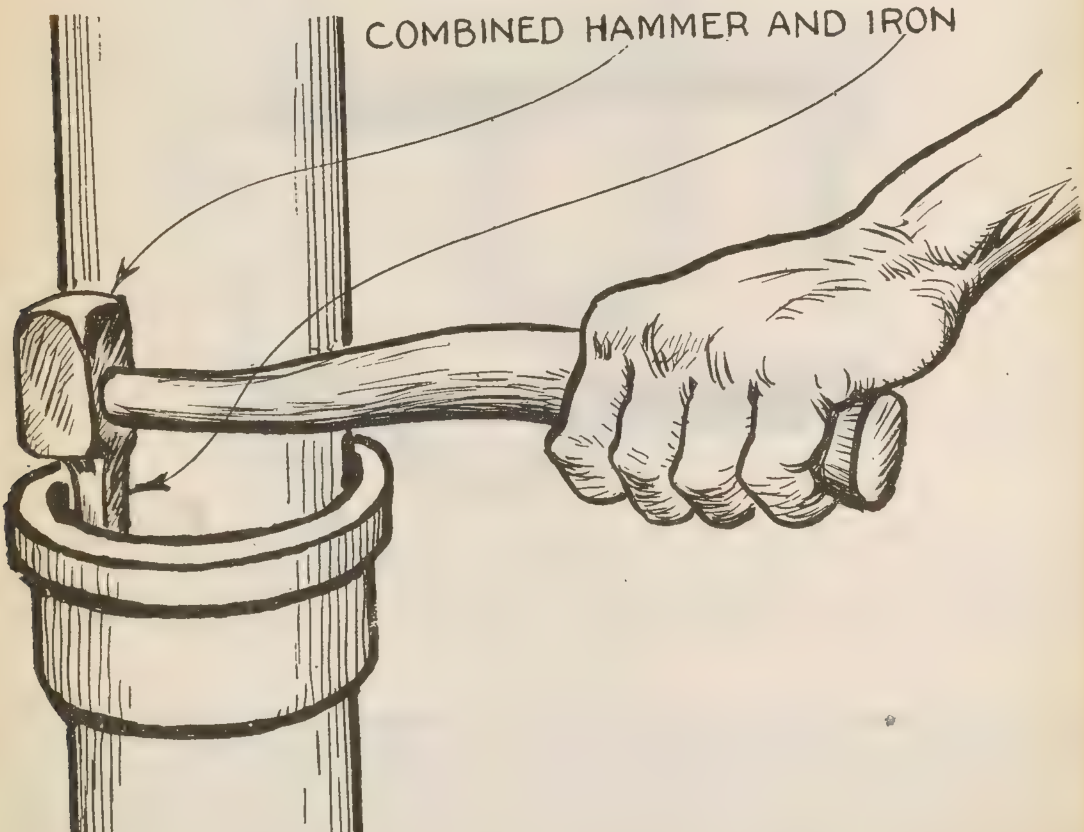
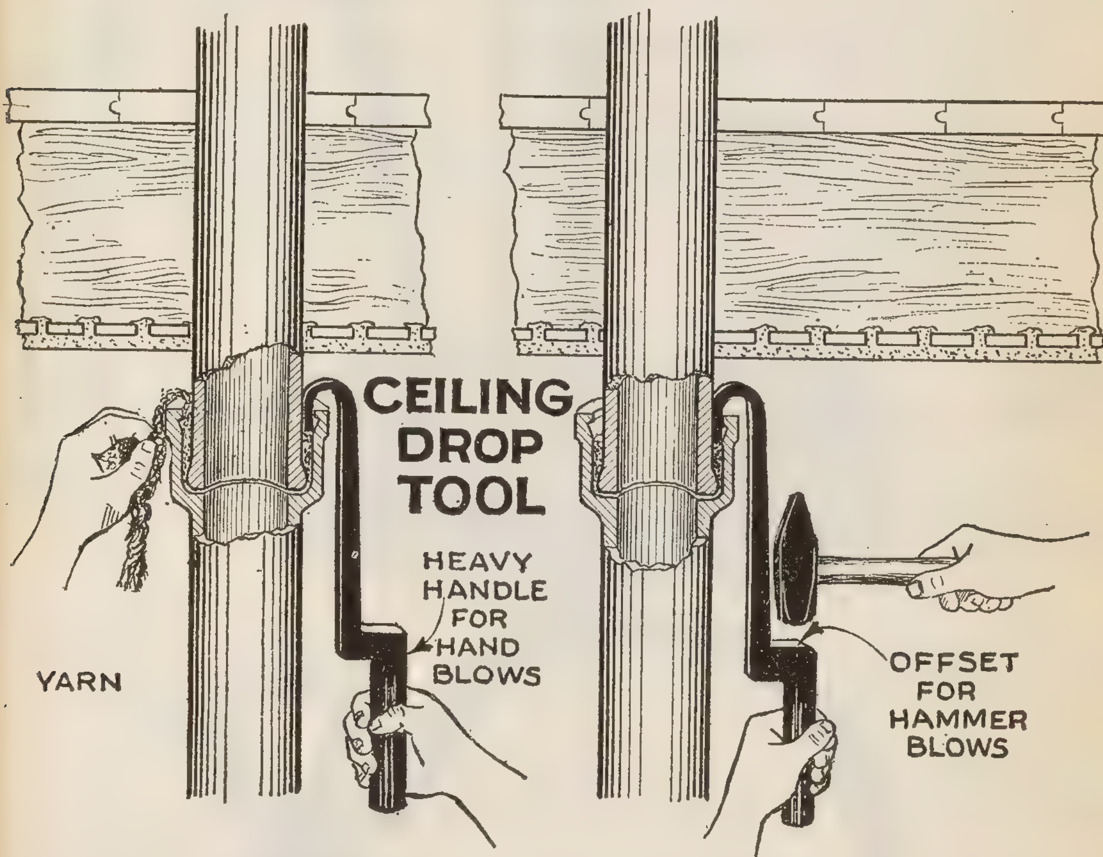


FIG. 6,806.—Method of using right and left concave combined yarning, or caulking irons and hammers.

compressed in the joint, evenly all around, the next operation is pouring the lead.

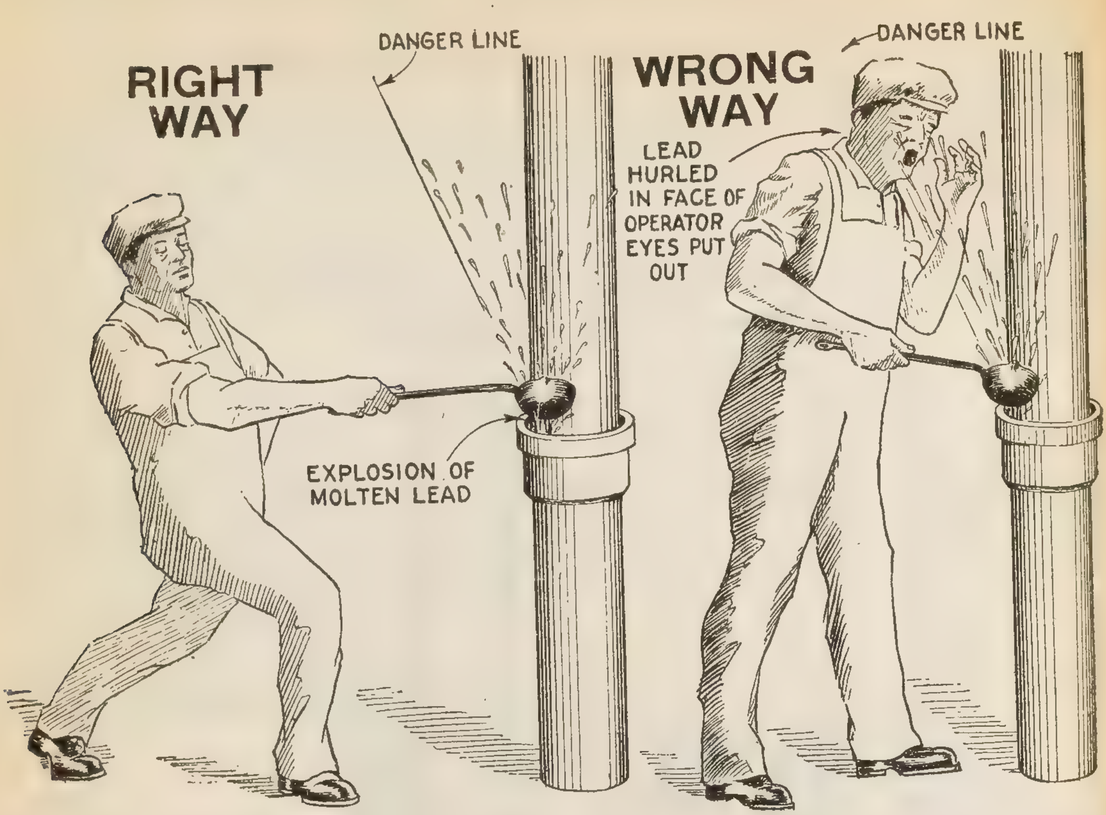
The table just given shows the amount of lead required for the various sizes of pipe.* It is important that the socket be filled at one pouring hence, first melt up plenty of lead, and then dip out of the pot with the pouring ladle an ample supply to fill the socket without a second dipping.



Figs. 6,807 and 6,808.—Method of using ceiling drop tool in packing socket near ceiling. Fig. 6,807, first operation, forcing in the yarn with hand blows; fig. 6,808, second operation, packing down the yarn with hammer blows.

Before pouring care should be taken to see that there are no projecting strands of oakum, otherwise when the lead is poured

*NOTE.—The actual amount of lead required will of course depend upon the proportion of oakum and lead put into the socket. About one lb. of lead is required for each inch in bore of the pipe on the average for each joint.



FIGS. 6,809 and 6,810.—***Right*** and ***wrong*** way to pour lead in making up a *vertical* bell and spigot joint. ***Always*** *keep clear of range through which the molten lead might be hurled in case of explosion by contact of the molten lead with water.*

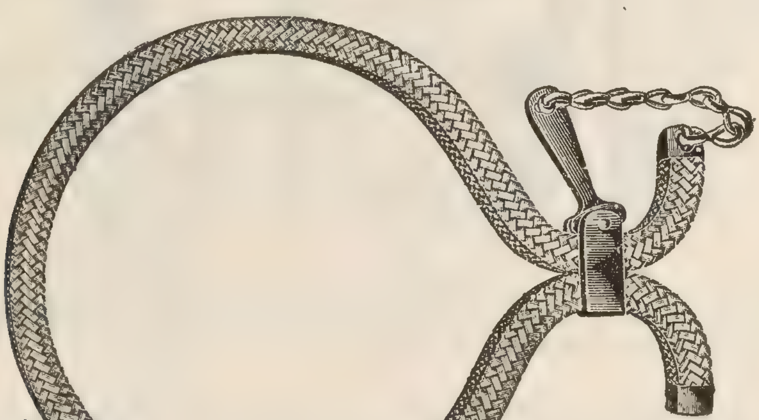


FIG. 6,811.—Square braided asbestos lead joint runner, showing clamp in position.

these strands will be consumed leaving minute ducts through the lead to cause leakage.

Care should be taken that socket is quite dry before pouring, as the molten lead would turn any water into steam causing an explosion.

There should not be any moisture in the joint when the lead is poured, because the sudden generation of steam by contact of the molten lead with the moisture will hurl the lead out of the joint with explosive force, possibly injuring the plumber.

To guard against injury from explosion, the plumber should stand as far away from the ladle as possible and *out of range* of

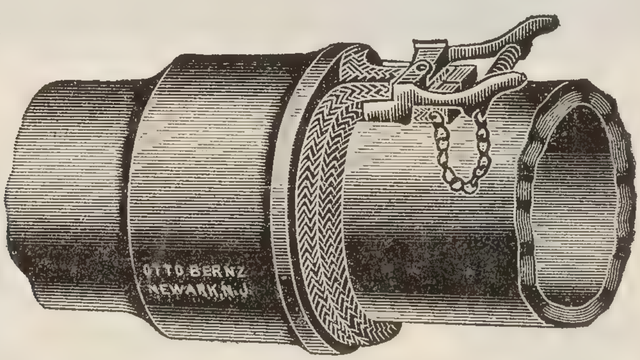


FIG. 6,812.—Square braided asbestos lead joint runner in position on pipe against end of bell. Evidently this closes the socket all around except at the junction at the top near the clamp.

the direction in which the lead would blow. The right and wrong way of pouring a vertical joint is shown in figs. 6,809 and 6,810.

If it be necessary to pour a wet joint, first tightly pack the oakum, then sprinkle in a teaspoonful of powdered rosin, or oil if rosin be not available. The object of this is to prevent the flying of the molten lead when it strikes the moisture. *Extreme caution, however, should be taken* in pouring where there is moisture.

When lead is to be poured into a horizontal joint a *joint runner* as shown in fig. 6,812 is used.

The method of attaching this type of runner to the pipe is shown in fig. 6,813. As here shown, and also in fig. 6,815 the end of the socket is closed by the joint runner all around except at the top, so that when the molten lead is poured into the socket through this small opening it will not escape but will be held in the socket by the joint runner till it cools and solidifies. The runner is then removed and the lead caulked to insure a tight joint.

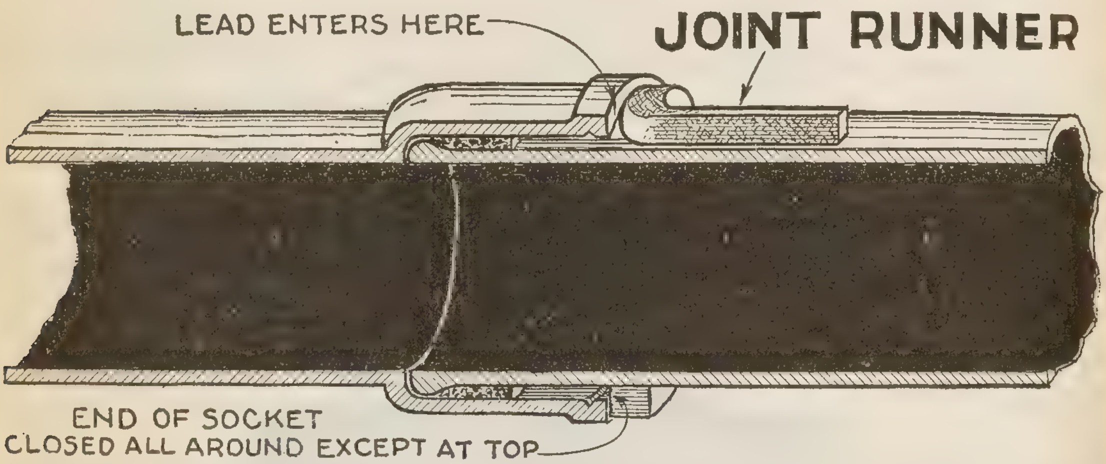
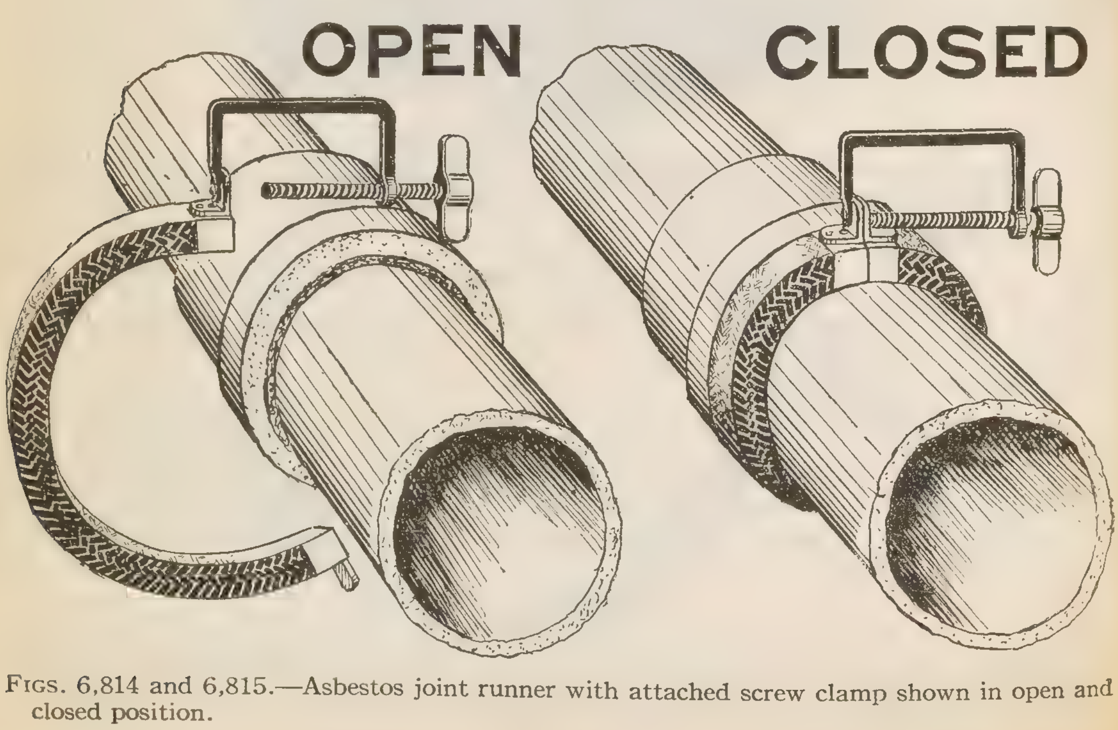


Fig. 6,813.—Sectional view of bell and spigot joint with joint runner in position ready for pouring the lead illustrating the closure of the socket all around except at the top so that the lead will not run out of the socket when poured.

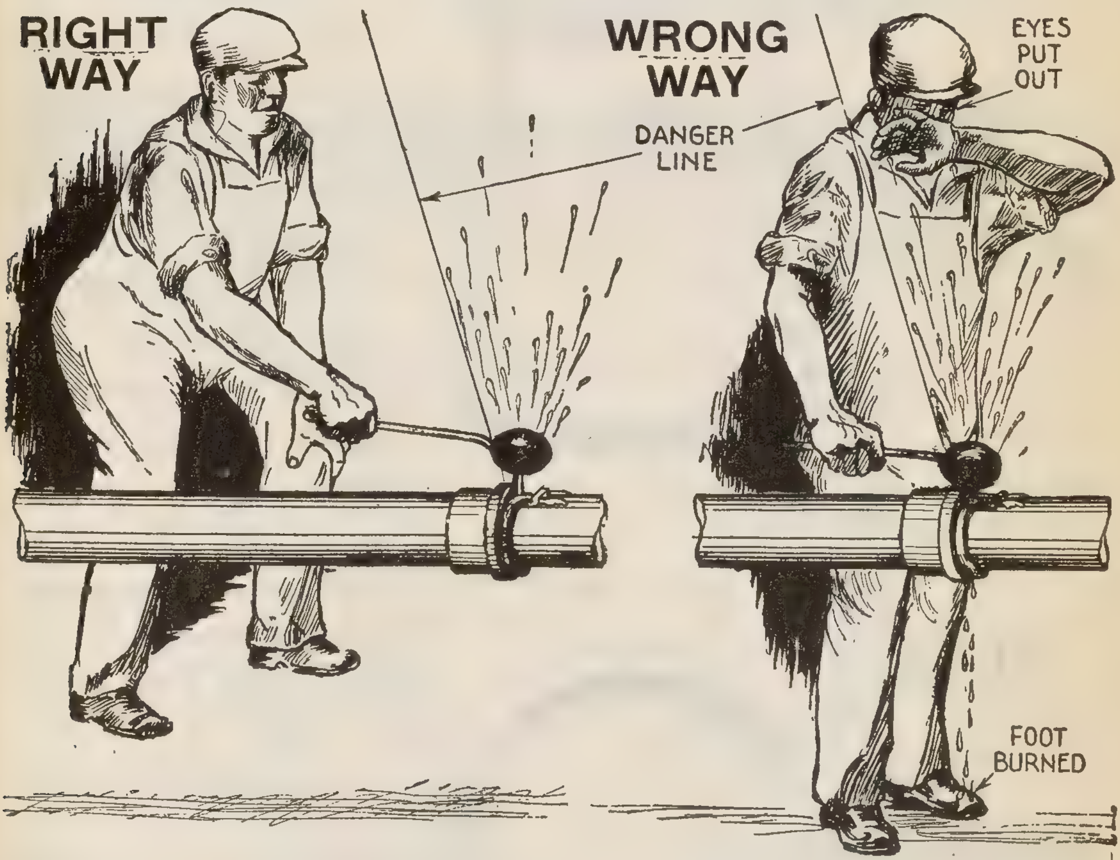


Figs. 6,814 and 6,815.—Asbestos joint runner with attached screw clamp shown in open and closed position.

Figs. 6,814 and 6,815 show another form of joint runner with clamp attached, the runner being shown in open and closed positions.

To avoid possible injury from flying lead the plumber should stand out of range the same as in pouring a vertical joint. Figs. 6,816 and 6,817 show the right and wrong position in pouring the joint and the grave possibility of injury to a careless workman.

Never **monkey** *with molten lead*—its no man's friend when it suddenly comes in contact with water.

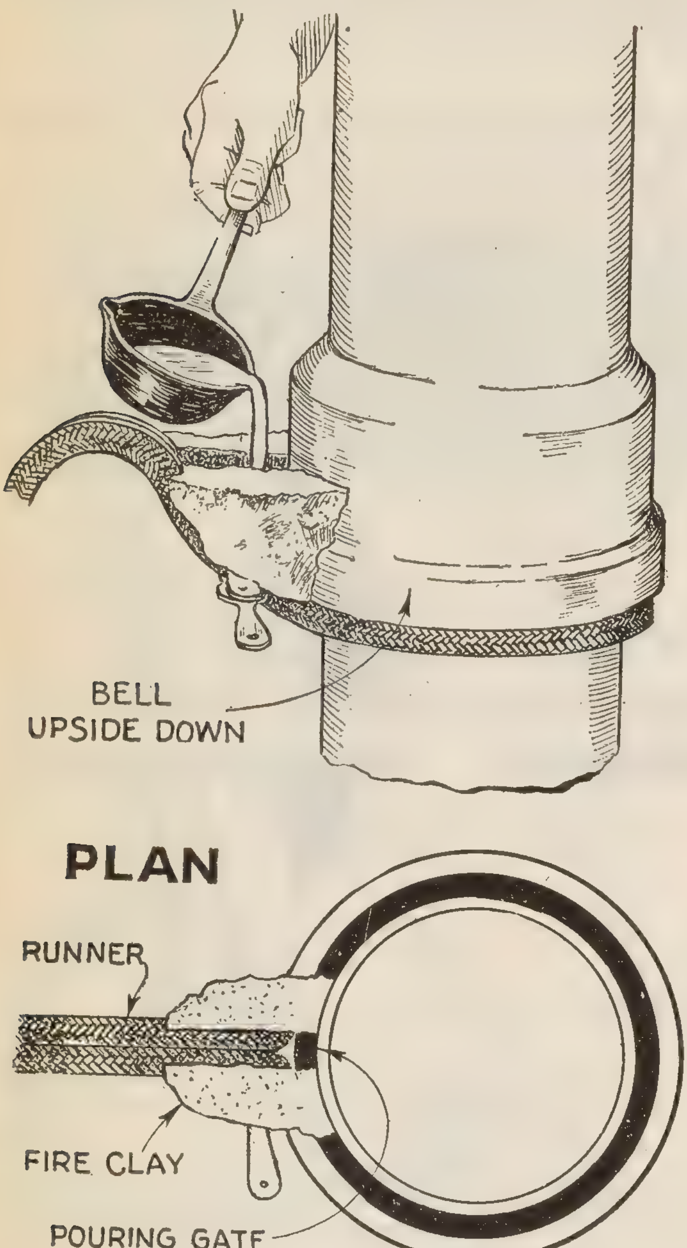


FIGS. 6,816 and 6,817.—***Right*** and ***wrong*** way to pour lead in making up a *horizontal* bell and spigot joint. Note the danger line and keep back of it to avoid injury in case the lead "blows."

NOTE.—***An inefficient or unscrupuious workman*** will not possess, or will "*forget*" (?) to bring a joint runner, and as a poor makeshift will use a fire clay-roll, formed about a strong cord by hand with clay just damp enough to bend and pinch in place. While a joint can sometimes be poured with this rig, in most cases, the weight of the lead, aided by steam bubbles formed from the moisture in the clay displaces the runner and the joint has to be repoured. Such practice is inexcusable, and is neither fair to the workman's reputation or the man who pays the bill. The same thing may be said of the pipe fitter who uses a coupling on the end of a pipe as a nipple holder. *Good jobs cannot be done with makeshifts.*

Sometimes it is necessary to pour a joint upside down.

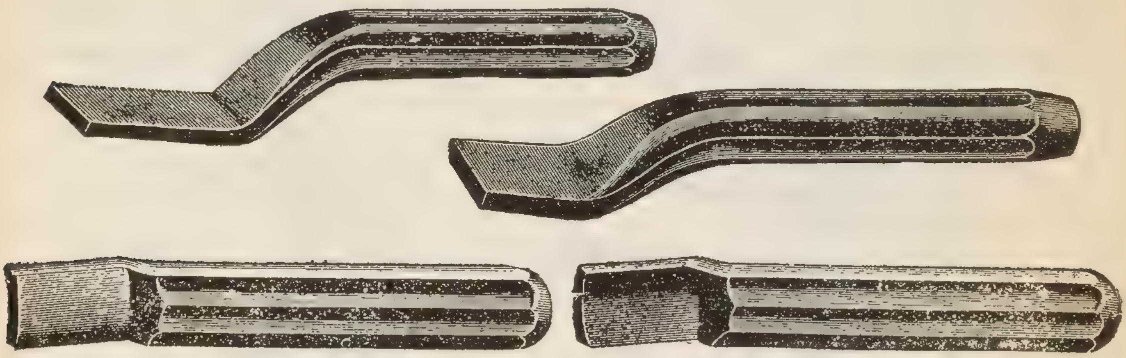
This may be done by placing the joint runner around the pipe and clamping as shown in figs. 6,818 and 6,819, a pouring gate being formed by building up walls of fire clay between the runner and the bell.



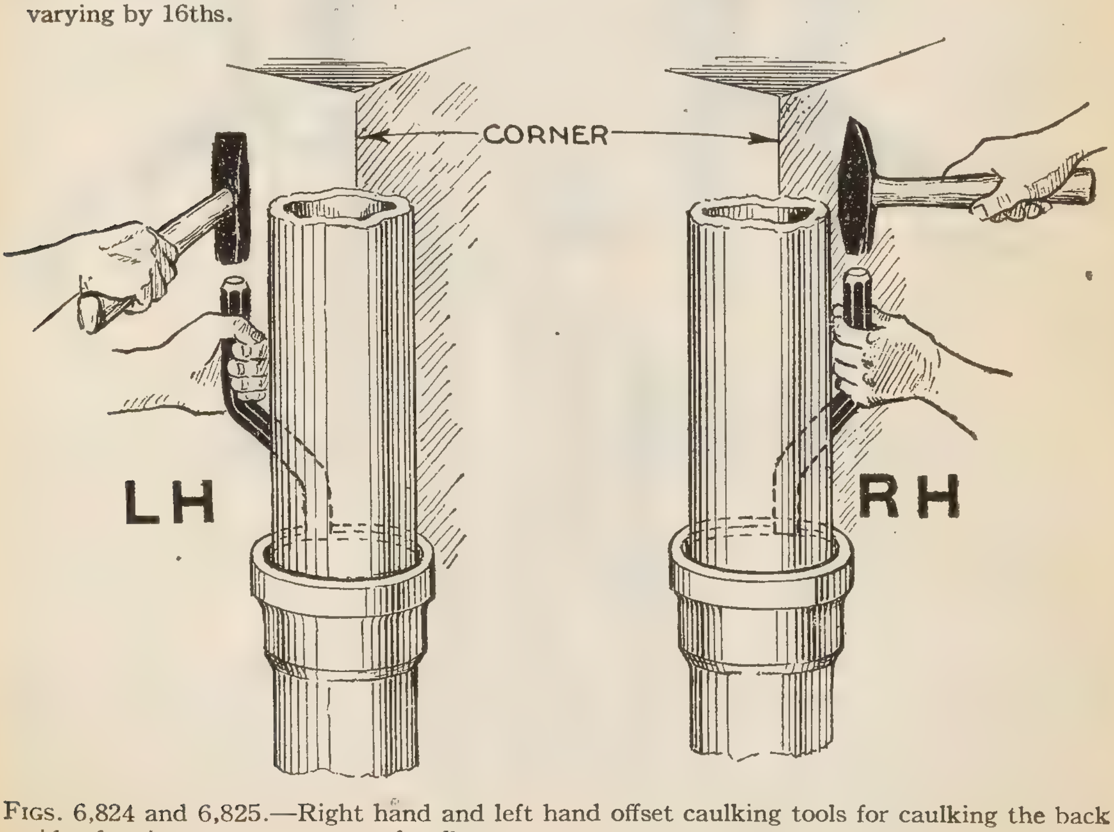
FIGS. 6,818 and 6,819.—Method of pouring joint upside down. The runner is first placed around the pipe and turned up, in which position it is clamped. A pouring gate is then formed with fire clay as shown.

Caulking the Lead.—After pouring the lead, the next operation is caulking, which is done with a caulking tool. These are similar to yarning tools except that the blade is shorter and heavier. Some caulk while the joint is hot, others after it has cooled. The best method is to caulk moderately tight while the joint is hot so that the lead will better adjust itself to irregularities of the socket walls. After the joint has cooled the caulking is finished by driving the lead into contact

with the spigot surface on one edge and against the inner surface of the bell on the other. Where the joint is fully accessible regular pattern tools are used as shown in figs. 6,820 to 6,823.



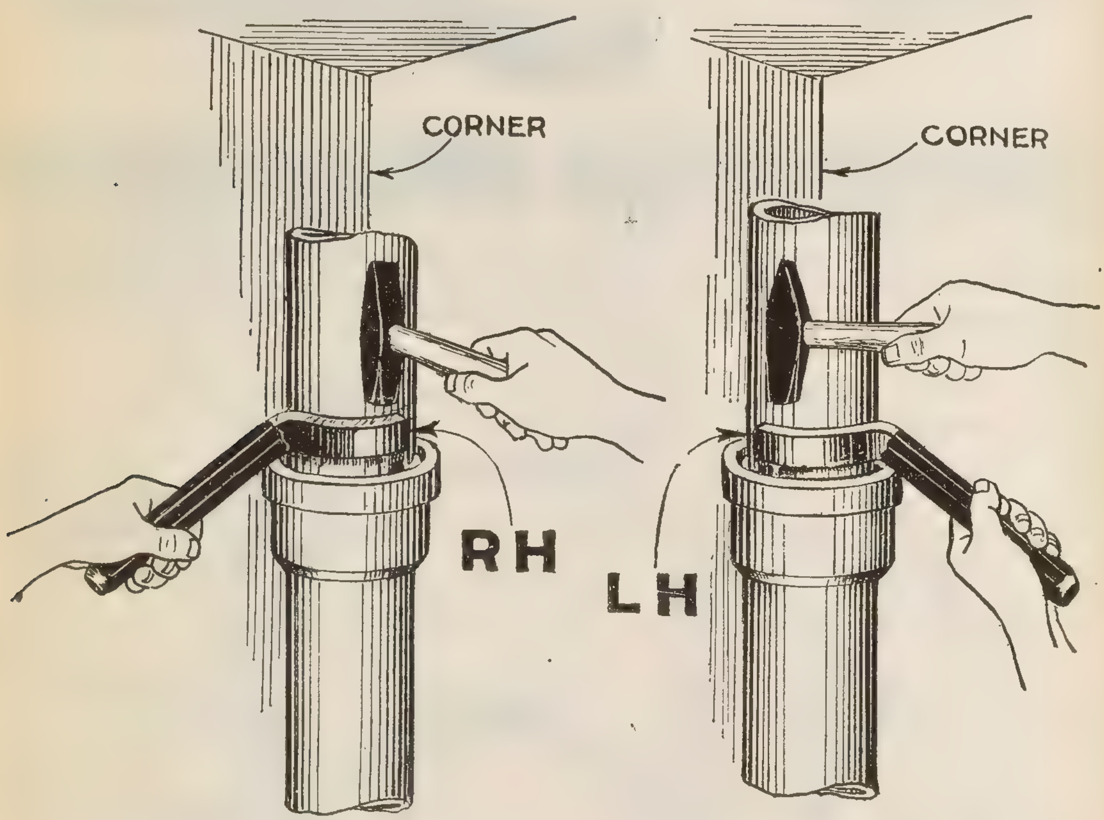
FIGS. 6,820 to 6,823.—Regular caulking tools for caulking in accessible places. Fig. 6,820, light stub pattern; fig. 6,821, heavy stub pattern; fig. 6,822, convex pattern; fig. 6,823, concave pattern. ***The thickness of blade*** of these tools ordinarily ranges from ⅛ to ½ in. varying by 16ths.



FIGS. 6,824 and 6,825.—Right hand and left hand offset caulking tools for caulking the back side of a pipe run near corner of wall.

Similarly, as in yarning operations, there is a multiplicity of *special* caulking tools to facilitate caulking in close places. Figs. 6,824 to 6,837, show some shapes very frequently employed and how they are used.

Cutting Soil Pipe.—In any job of pipe fitting there will be numerous places where it is necessary to cut a length of pipe to make up the line. This is because the pipe is cast in standard



FIGS. 6,826 and 6,827.—Right hand and left hand S iron caulking tools. These tools are sometimes used in preference to *r* and *l* offset tools.

lengths usually 5 ft., hence unless the distance between the first and last joints of a line be a multiple of 5, there will be an odd length less than 5 ft., necessitating the cutting of a 5 ft. length to obtain the short piece of pipe needed to complete the line.

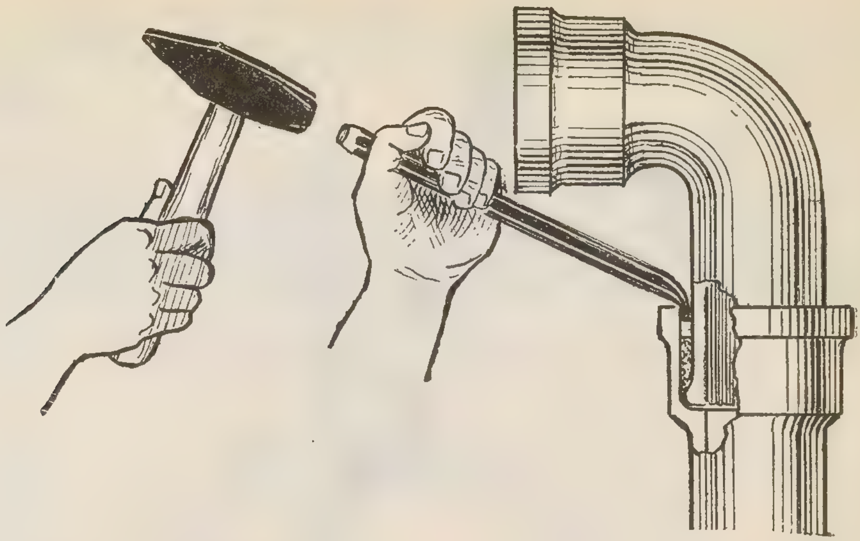


FIG. 6,828.—Throat caulking tool.

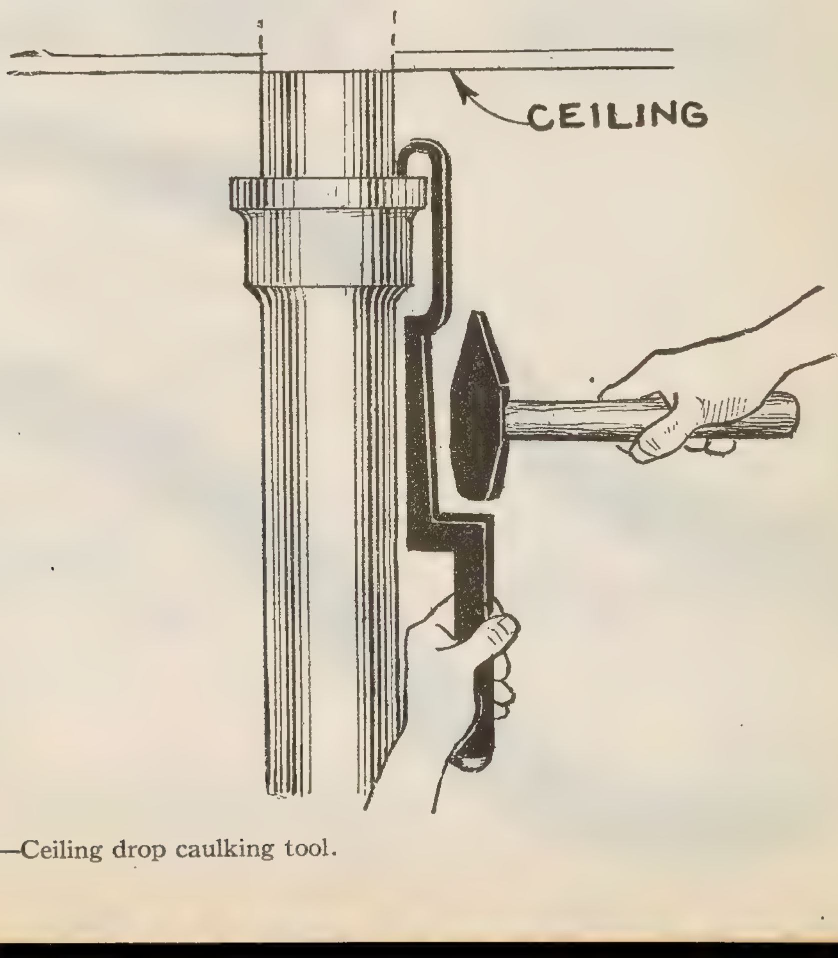


FIG. 6,829.—Ceiling drop caulking tool.

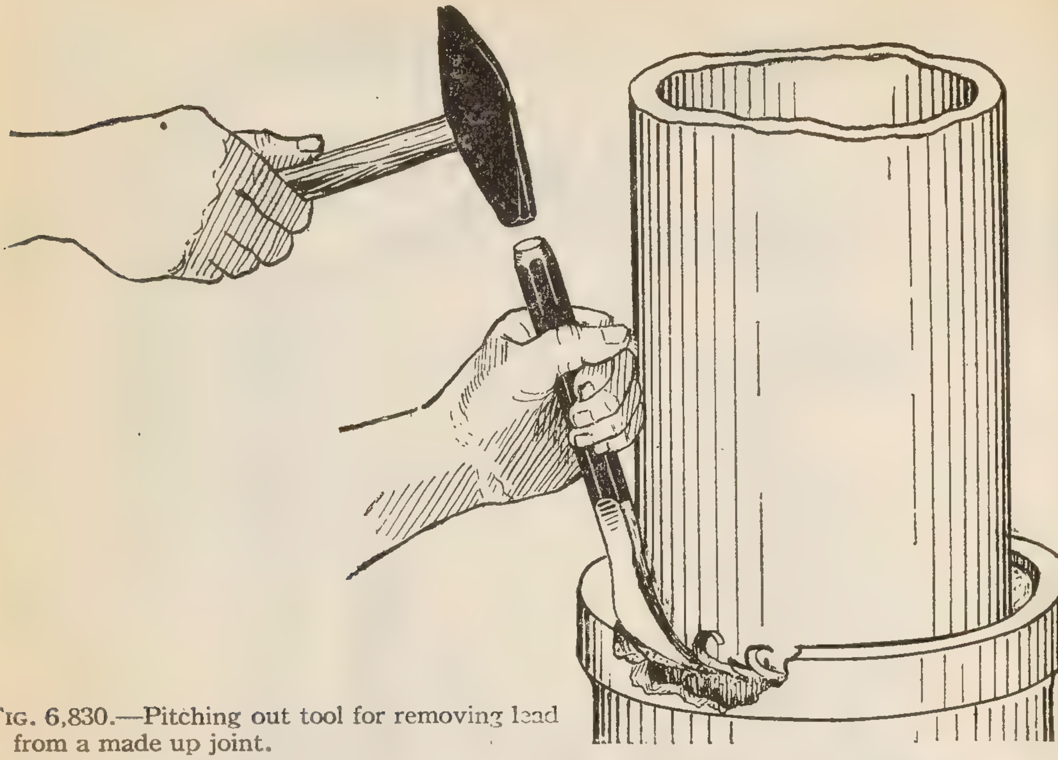
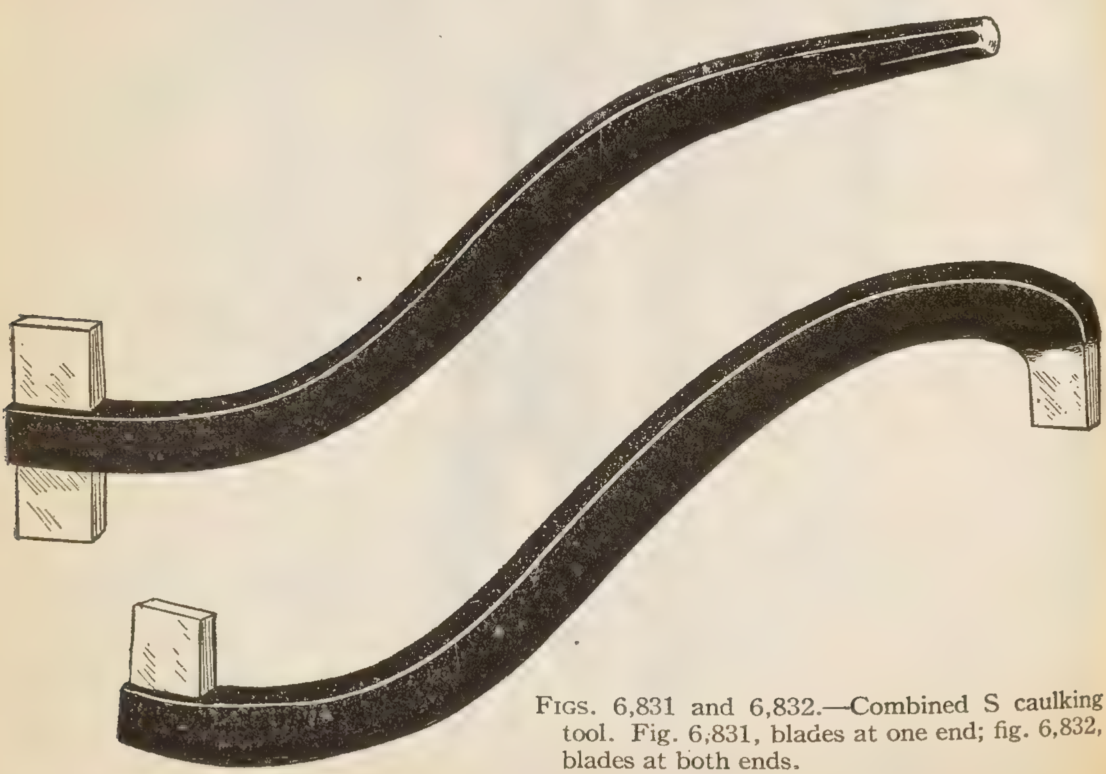


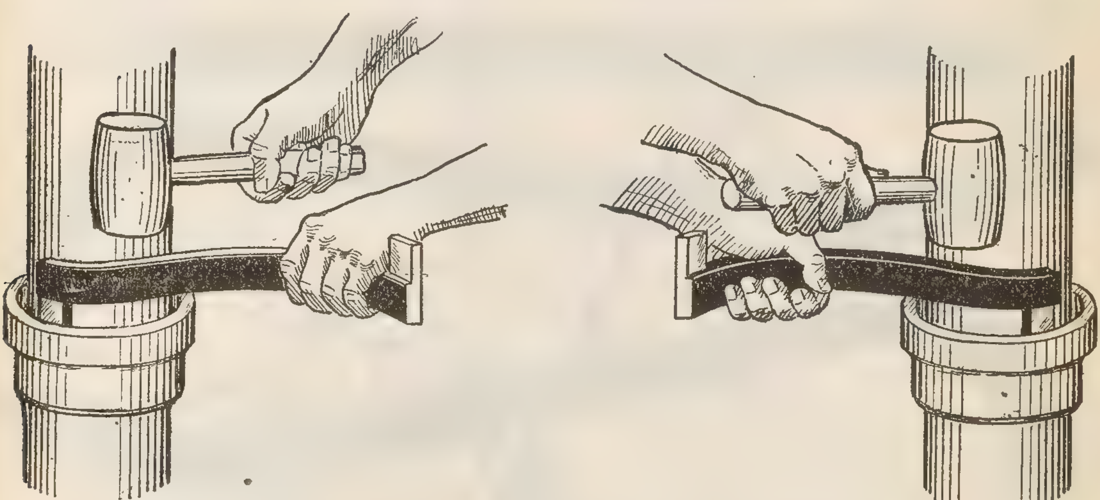
Fig. 6,830.—Pitching out tool for removing lead from a made up joint.



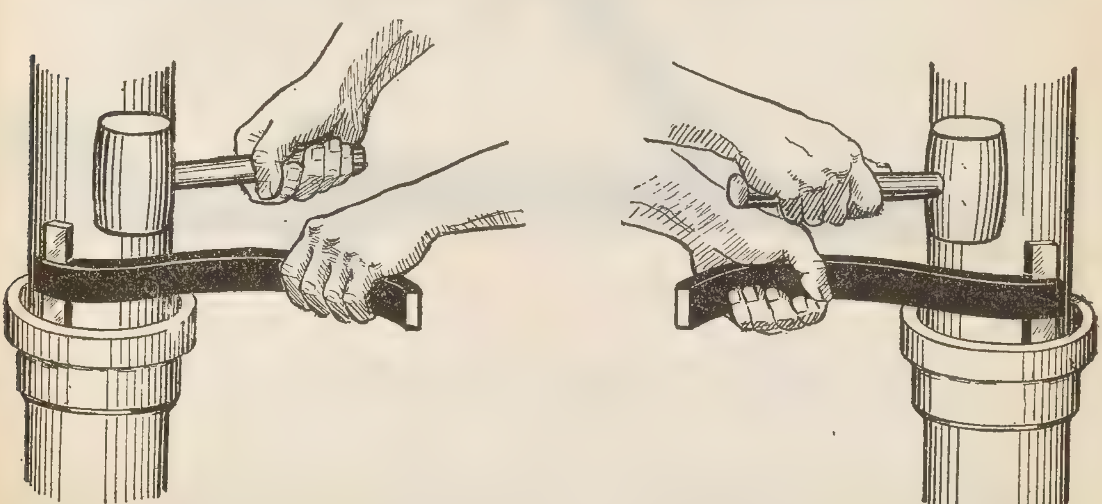
Figs. 6,831 and 6,832.—Combined S caulking tool. Fig. 6,831, blades at one end; fig. 6,832, blades at both ends.

The full 5 ft. length will have a bell (or hub) on one end and a spigot (or bead) on the other as shown in fig. 6,833 and called *single bell* pipe.

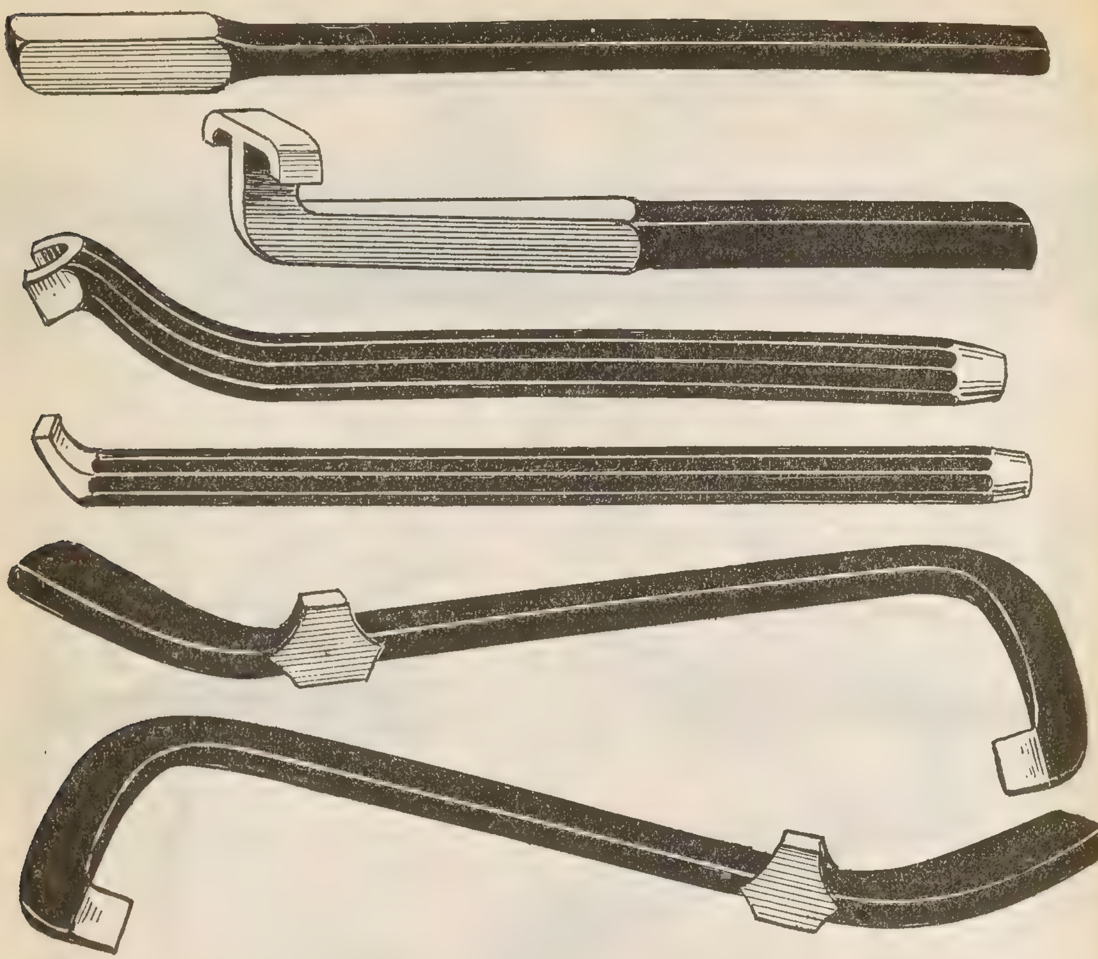
FIG. 6,833.—Single bell cast iron soil pipe made in standard 5 ft. lengths and various thicknesses or weights."



FIGS. 6,834 and 6,835.—Application of S caulking tool with blades at both ends.



FIGS. 6,836 and 6,837.—Application of S caulking tool with blades at one end.



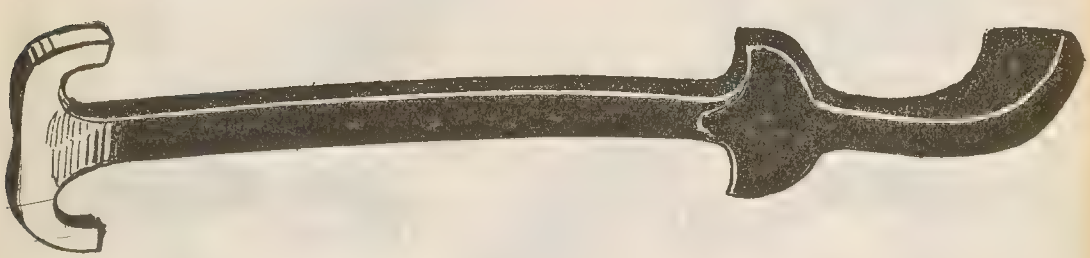


FIG. 6,838.—Mueller soil pipe caulking hammer designed to be used with the Mueller caulking tools illustrated in the accompanying cuts.

FIGS. 6,839 to 6,844.—Mueller pattern caulking tools. Fig. 6,839 combined *r* and *l*, iron; fig. 6,840, handy pattern combined *r* and *l*, iron; fig. 6,841, eighth bend iron; fig. 6,842, *right* drop pattern iron; fig. 6,843, *left* drop pattern iron; fig. 6,844, combined *r* and *l*, iron.

Evidently if a length of single bell pipe be cut to obtain a short length, the spigot end would be of no use, resulting in waste. To avoid this, a *double bell* pattern pipe is used as shown in fig. 6,848; when this is cut each piece will have a bell so that it may be used. Accordingly in ordering pipe for any installation a few lengths of double bell pattern pipe should be included to avoid waste in cutting.

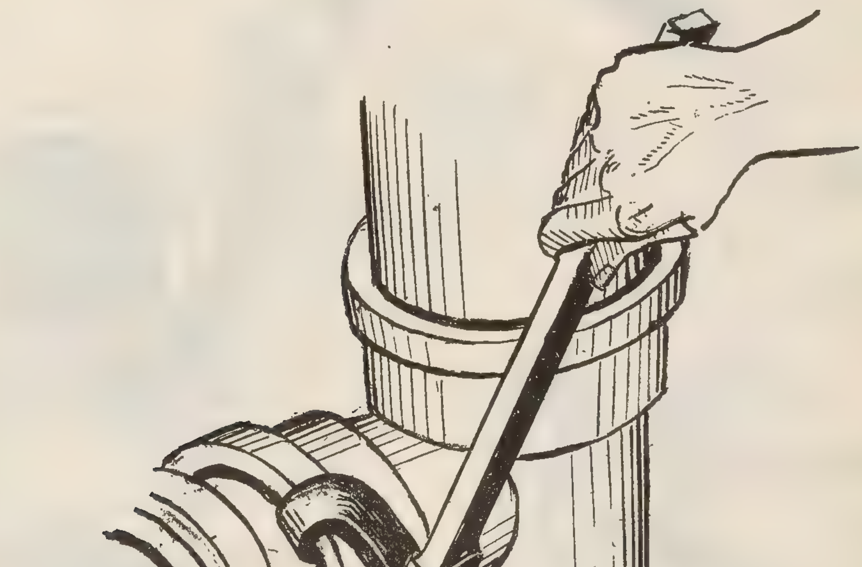
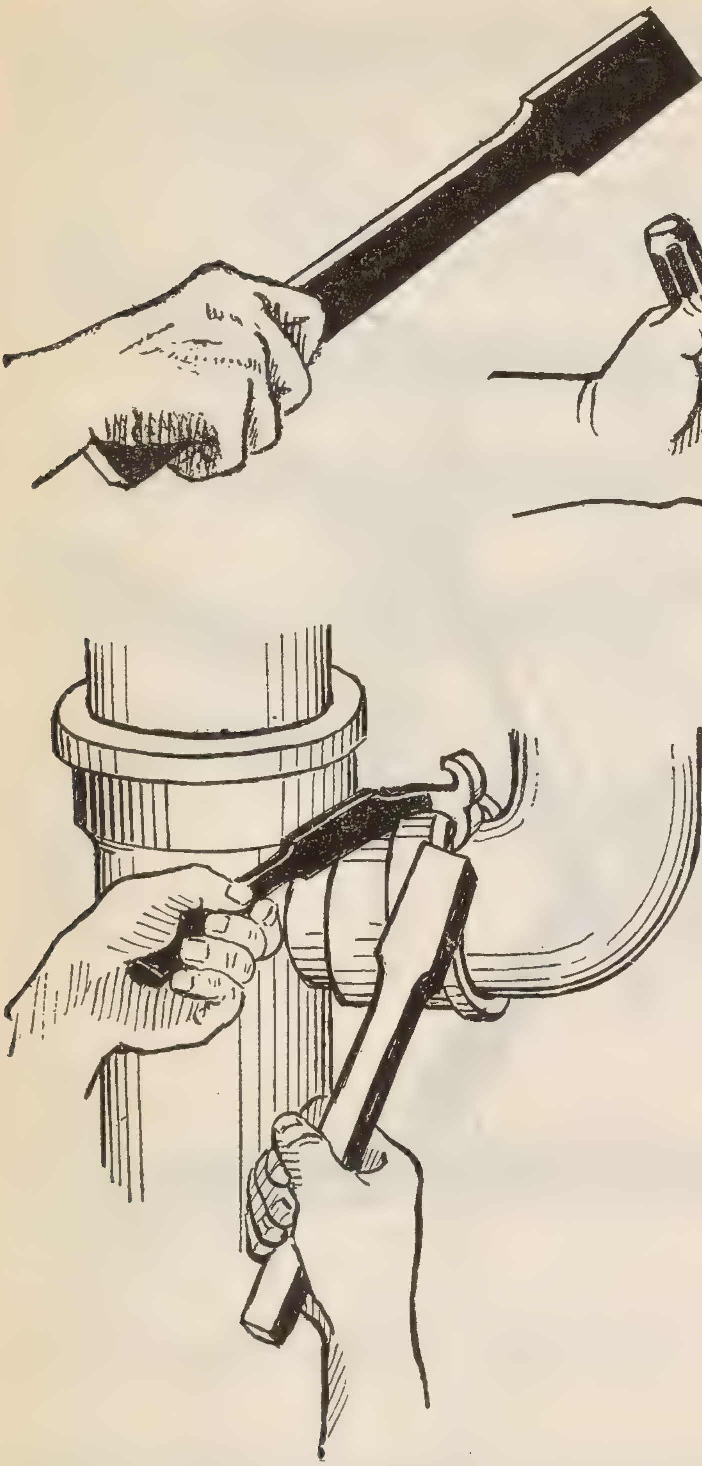


FIG. 6,845.—Method of using Mueller helper pattern caulking iron in caulking branch of T fitting.



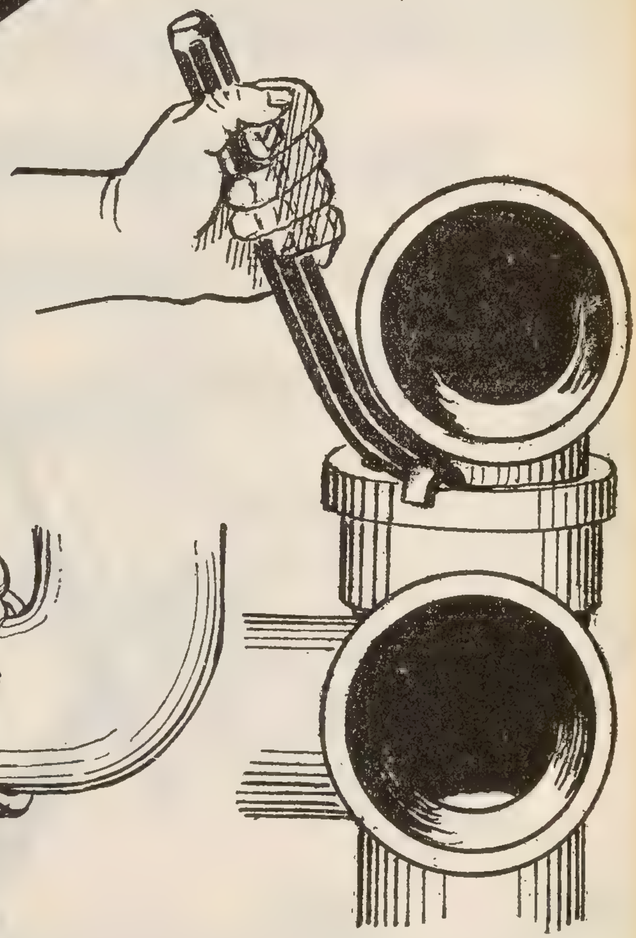
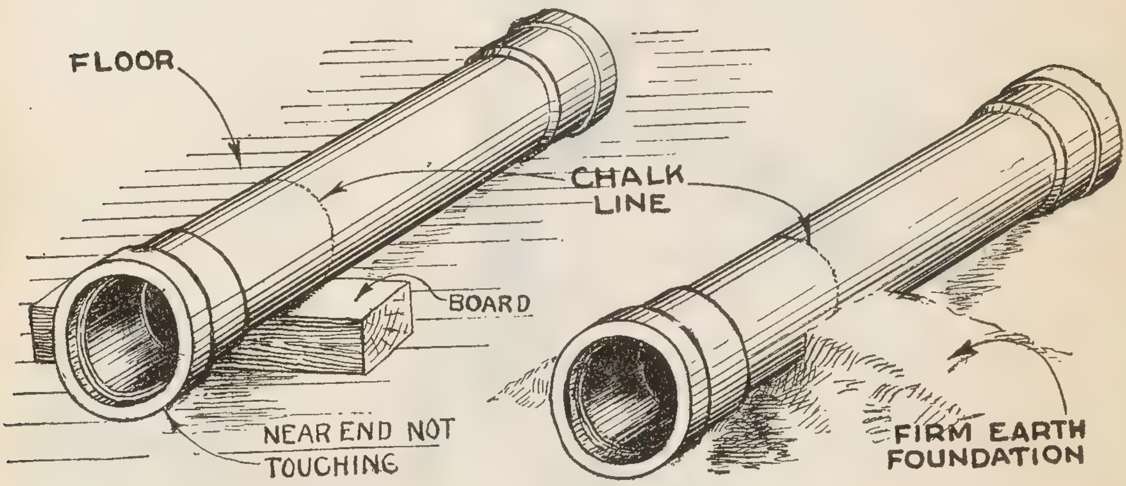


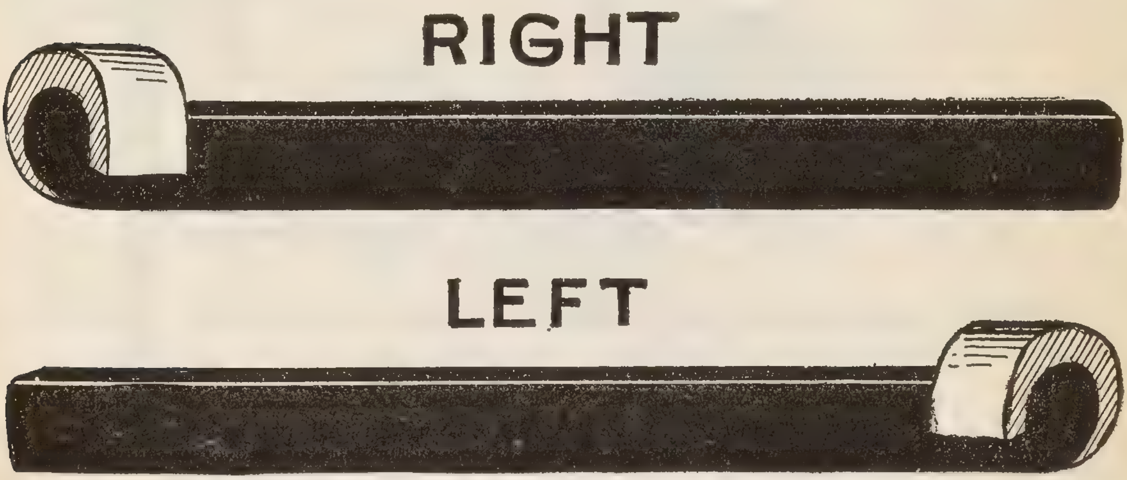
FIG. 6,847.—Method of using Mueller "handy pattern" combined *r* and *l* caulking iron in caulking throat of elbow.

FIG. 6,846.—Method of using Mueller "helper pattern" combined *r* and *l* caulking iron in caulking branch of T fitting and elbow.

FIG. 6,848.—Double bell cast iron soil pipe for cutting to odd lengths.



FIGS. 6,849 and 6,850.—Methods of supporting soil pipe in cutting. Fig. 6,849, on floor; fig. 6,850, on earth.



FIGS. 6,851 and 6,852.—Mueller "helper pattern" *r* and *l* *r*ight and *l*eft caulking iron.

On cutting, first make a chalk mark entirely around the pipe where it is to be cut. This mark should be true, not rambling. A hammer and sharp pointed cold chisel is better for cutting than wheel pipe cutters.

The pipe should be firmly supported on the floor with a block at the

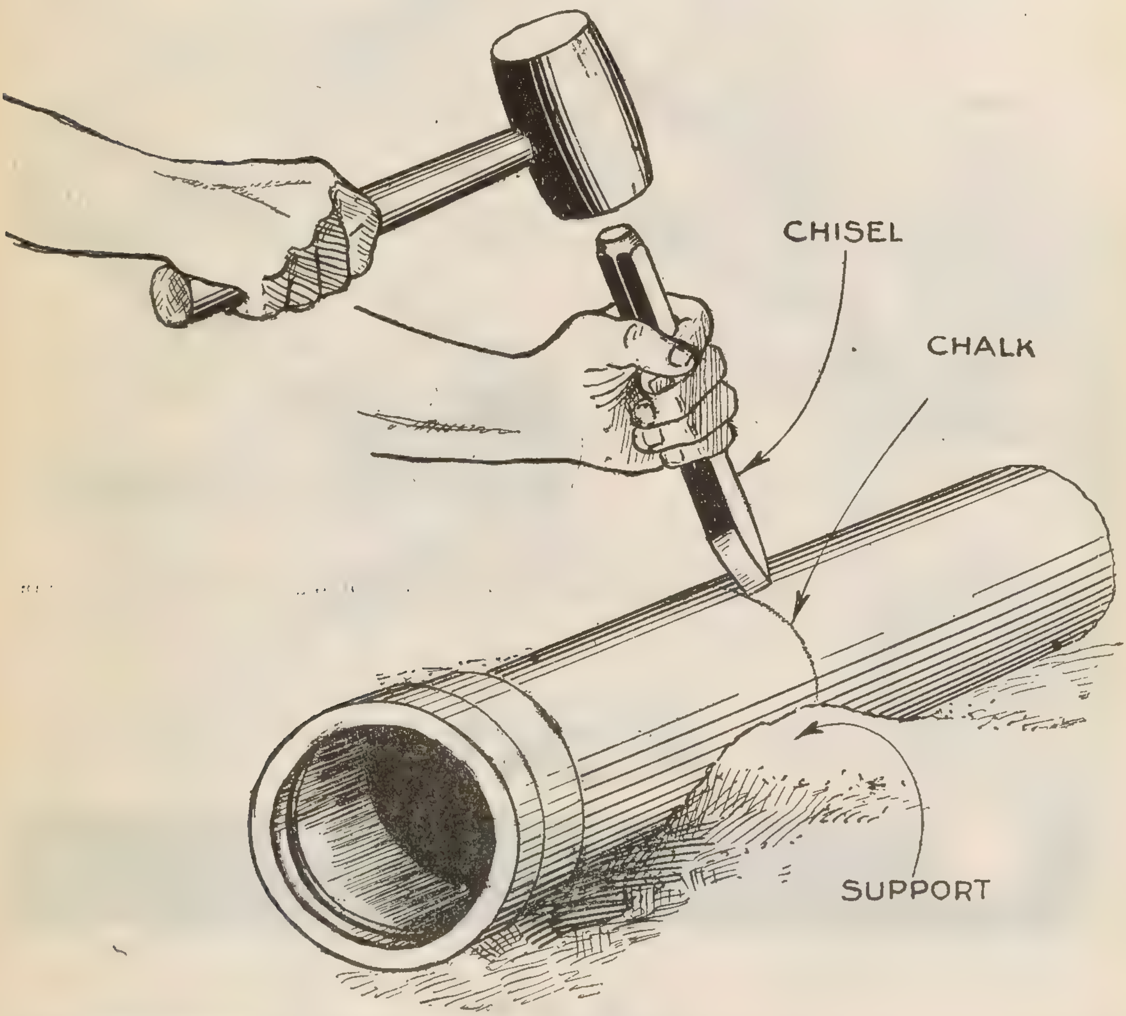


FIG. 6,853.—Method of cutting cast iron soil pipe with hammer and cold chisel, the pipe being firmly supported on a mound of earth.

cutting line as in fig. 6,849, or preferably on a mound of earth as in fig. 6,850. The cutting is done as in fig. 6,853. In cutting, the use of chisel and hammer as here shown is safer than cutting with wheel cutters on account of the liability to crack the pipe.

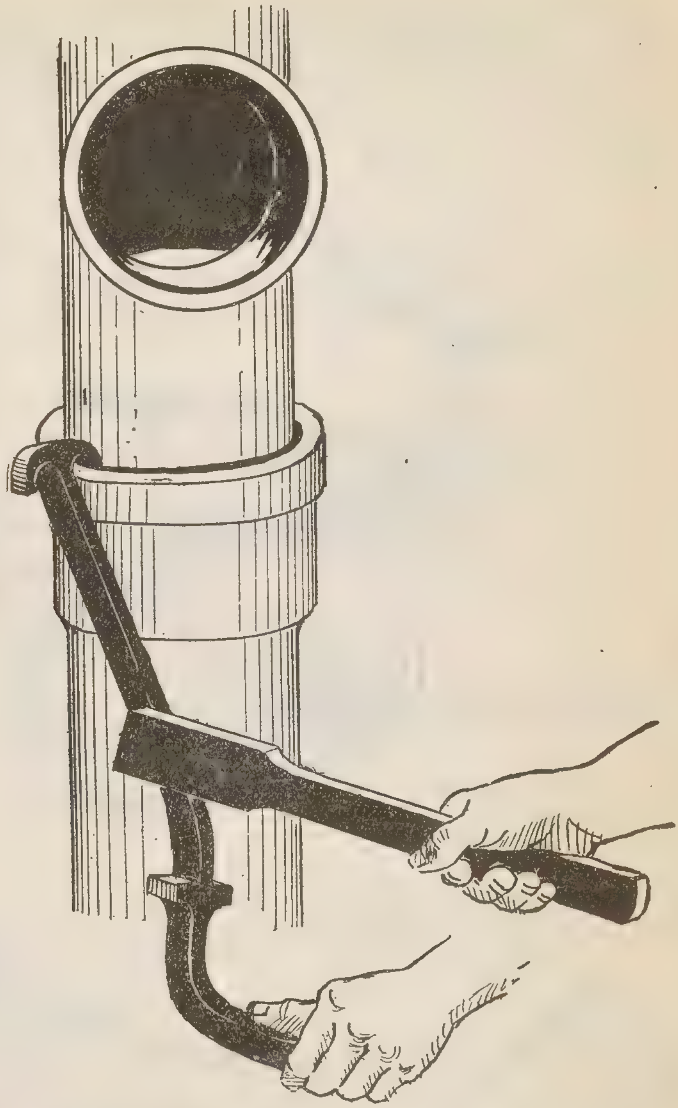


FIG. 6,854.—Method of using Mueller combined *r* and *l* drop pattern caulking iron in caulking high joint near ceiling.

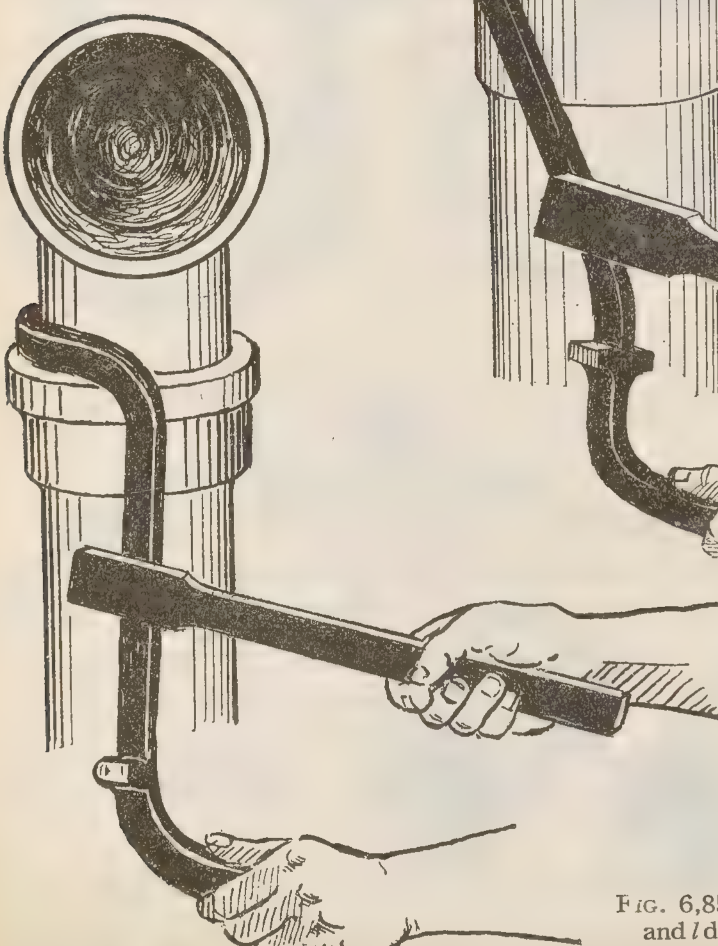


FIG. 6,855.—Method of using Mueller *r* and *l* drop pattern caulking irons in caulking high joint near ceiling.

The pipe is easily cracked with wheel cutters because it is often not of uniform thickness throughout and because with the cutters this variation in thickness cannot be so easily detected as with the chisel and hammer.

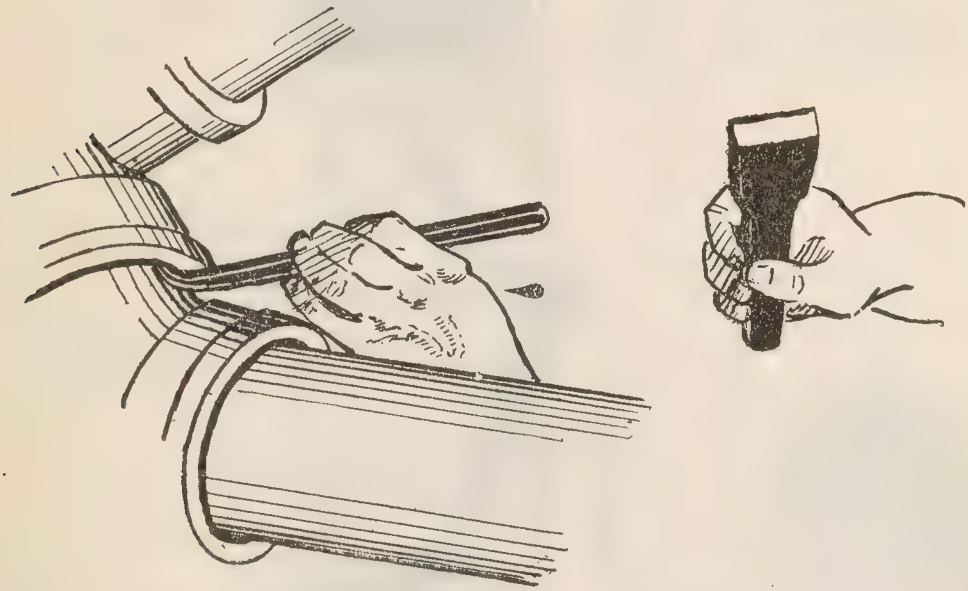


Fig. 6,856.—Method of using Mueller eighth bend pattern caulking iron in caulking eighth bend elbow.

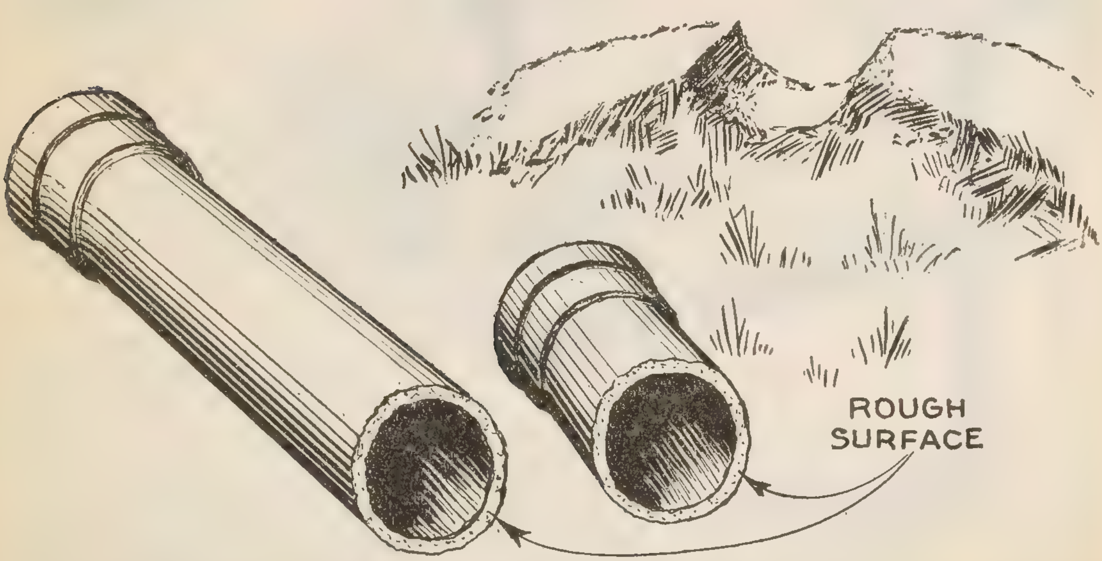


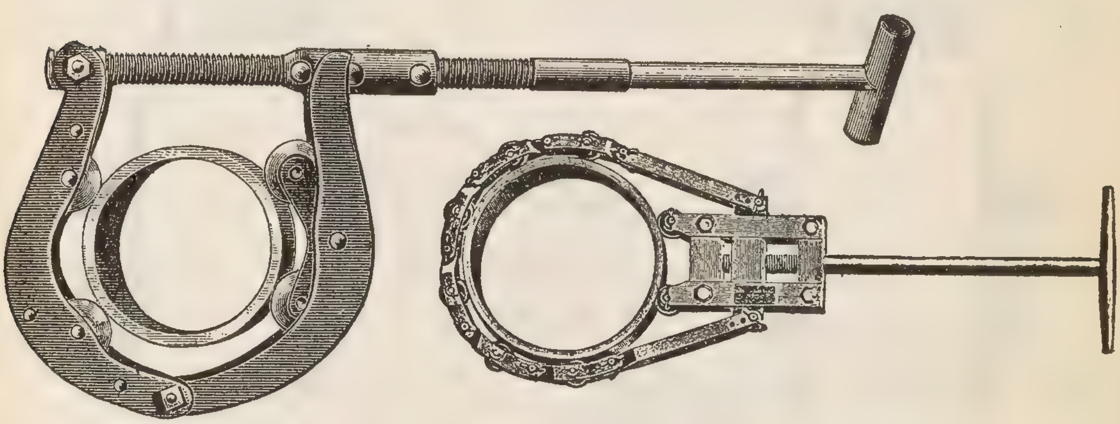
Fig. 6,857.—Double bell cast iron soil pipe after cutting with chisel and hammer showing appearance of cut.

With the latter, the ear is of great assistance in determining where the pipe is thick or thin as indicated by the sound produced in hammering.

When using a chisel and hammer, the chisel should be narrow and sharply pointed, and the hammer of medium weight.

Fig. 6,857 shows appearance of double bell pipe after cutting.

Two types of wheel cutter are shown in figs. 6,858 and 6,859, for small and large pipe respectively; the small cutter is shown in position on the pipe ready for cutting.



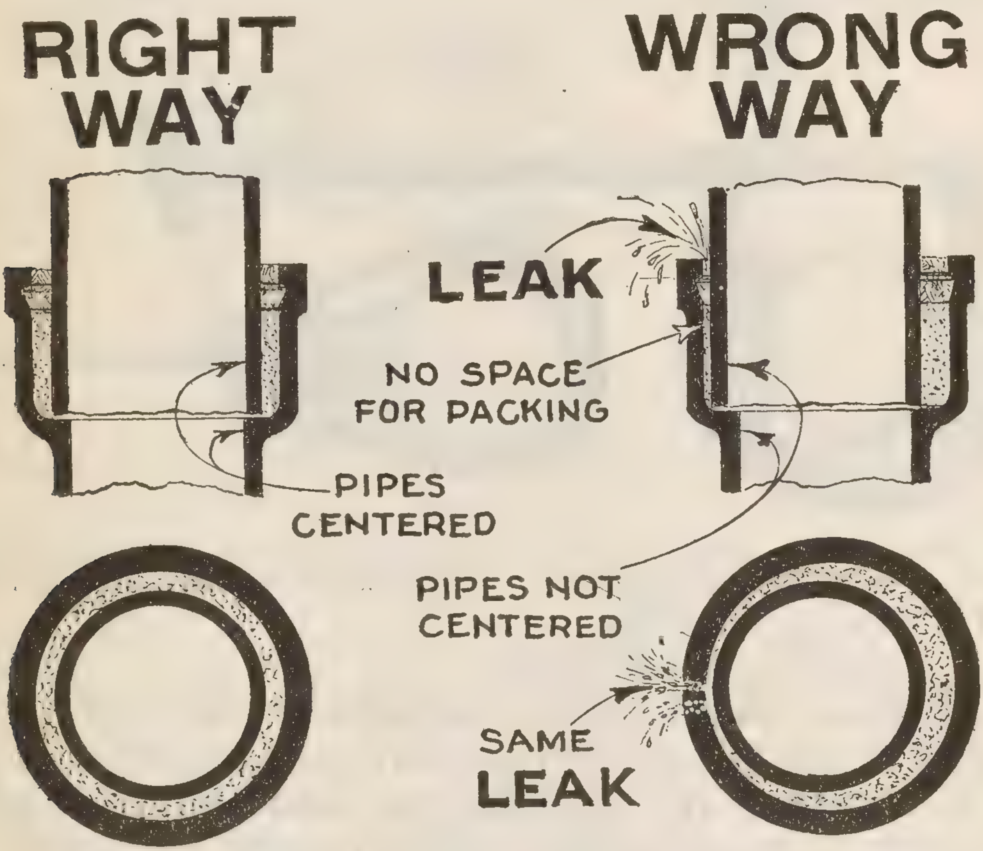
Figs. 6,858 and 6,859.—Wheel cutters for cast iron pipe. Fig. 6,858, Redfield four wheel cutter; fig. 6,859, Ellis eight wheel cutter. These cutters are operated the same as wrought pipe cutters.

A difficulty encountered in making up a joint with a cut piece of double bell pipe is that there is no spigot or bead on the end to center the pipe, and care must be taken to keep the cut end centered with the bell so that the packing will be of uniform thickness all around. If in packing the cut end be pushed to one side, it will be difficult to make a tight joint. Figs. 6,860 and 6,861 show the right and wrong way.

Wrought Pipe.—Considerable information on wrought pipe is given in Vol. I, Chapter 106, which includes data on the

manufacture, and strength of the pipe; system of screw threads used in jointing, etc.

Formerly wrought iron was almost exclusively used in the manufacture of wrought pipe, but because of its expense and also on account of the improved methods in the manufacture of steel pipe, conditions have been reversed and now almost all wrought pipe is made of steel.



FIGS. 6,860 and 6,861.—***Right and wrong way*** to make up joint with cut end of double bell pipe. Unless the pipes be centered with each other there will be at one point inadequate space for packing, making it difficult to insert the oakum at this point and to pour the lead resulting in a leaky joint as shown in fig. 6,861.

NOTE.—***The National Tube Company*** state that "the wisdom of their decision to make steel pipe only is shown by the fact that between 80 and 90 per cent. of the pipe used today in the United States is steel pipe. In addition to the advantage of better service by using steel pipe it is possible to save from twenty to thirty per cent. on the first cost, due to the fact that pipe steel is made by machine rather than by hand process."

The term wrought iron is often *erroneously* used to refer to pipes made to Briggs standard sizes rather than of the material, hence, in ordering pipe, if iron pipe be wanted instead of steel, care should be taken to specify *genuine wrought iron*, or *guaranteed wrought iron* pipe.

It is customary for manufacturers to stamp each length of such pipe as *genuine wrought iron* to distinguish it from steel, and *no wrought iron pipe should be accepted* as such without the stamp.

To adapt wrought pipe to different pressures, it is regularly made up in several weights as follows:

1. Merchant.
2. Standard.
3. Extra strong (or heavy).
4. Double extra strong (or heavy).

Merchant pipe is "short weight" pipe.

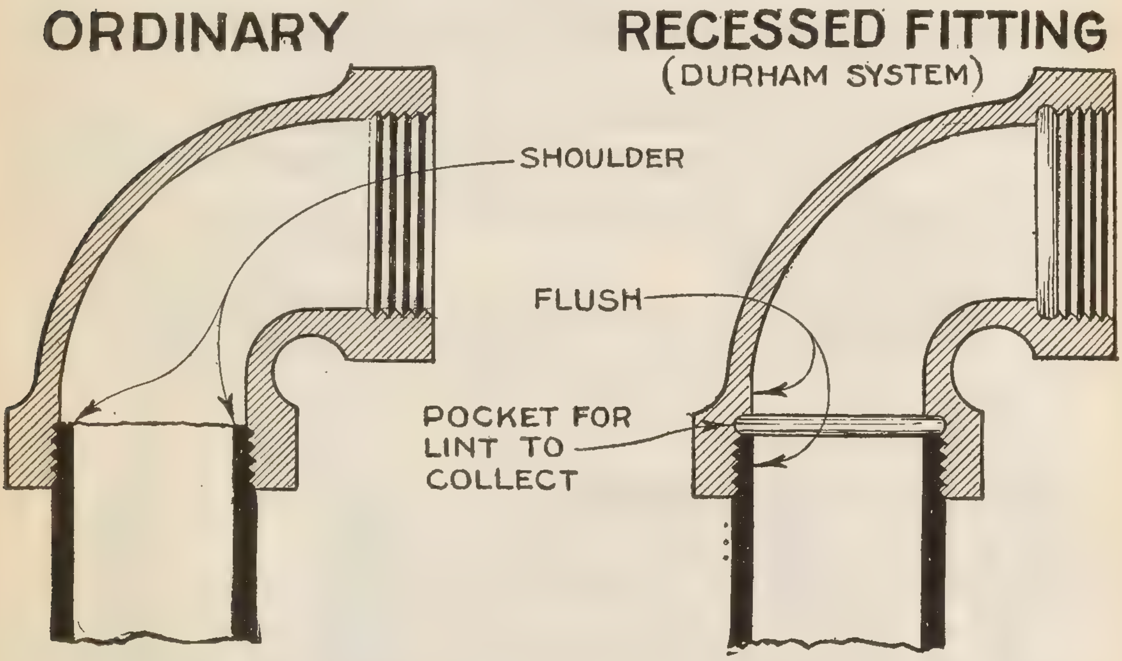
It is necessary to guard against this short weight pipe which formerly was extensively made to meet the demand of sharp jobbers, but now reputable companies have given up the manufacture of such pipe.

Merchant pipe is usually 5 to 10 per cent thinner than full weight pipe. It should be carefully avoided in work of any importance, as the extra cost of maintenance will soon overbalance the small difference in first cost. As a precaution against merchant pipe, orders should specify full weight pipe.

For drainage work no lighter pipe than standard weight should be used. The use of this pipe with recessed threaded fittings constitutes what is known as the Durham System.

This differs from ordinary wrought piping; in the recessed threaded joints of the fittings, the distinction being shown in figs. 6,860 and 6,861. The object of recessing the fittings is to bring the walls of the pipe and fittings flush with each other to avoid the projecting shoulder seen in fig. 6,862, which would form a place for the accumulation of lint and other foreign matter. The recessed fitting does not entirely overcome this trouble because instead of a shoulder there is a pocket due to the recess as seen in fig. 6,863, and here matter is liable to collect. Aside from this defect, the

wrought pipe used in the Durham system is less durable than cast iron. Its principal use is in high buildings because it is lighter than cast iron and takes up less space. Owing to its light weight it is placed in high buildings



FIGS. 6,862 and 6,863.—Distinction between ordinary wrought piping and Durham system. The only difference is the recessed fittings used to bring the walls of pipe and fittings flush to avoid shoulders which form resting places for the accumulation of lint and other foreign. matter.

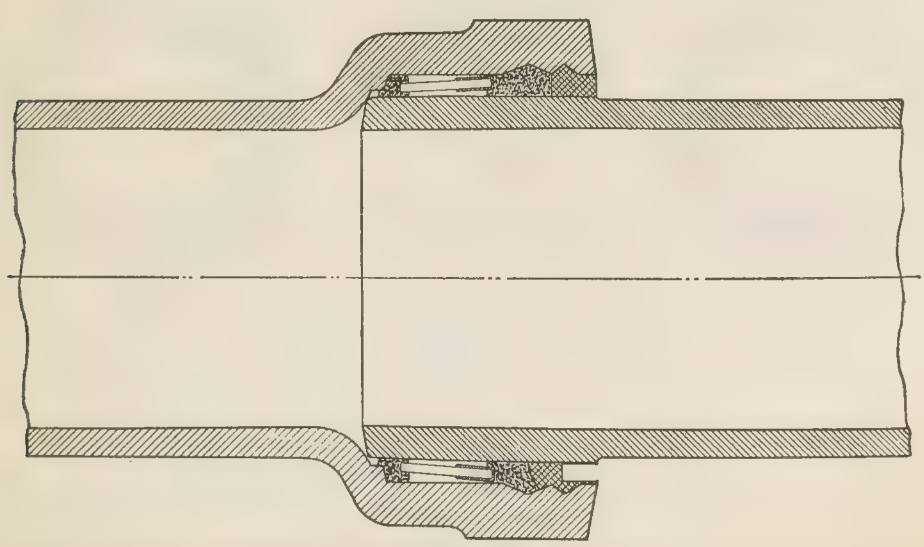


FIG. 6,864.—McWane pre-caulked bell and spigot joint, showing jute packing, lead packing, iron wedges in bell.

with not much more provision being made for supporting its great weight than is made with cast iron in a private dwelling.

The fittings used in the Durham System are described in Chapter 120 on *drainage* fittings, and the method of making up the joint in Chapter 121 on pipe fitting.

FIG. 6,865.—McWane pre-caulked joint cast iron pipe line being connected up in a large southern city by an unskilled workman.

Coated Cast Iron Pipe.—Standard pipe is dipped in hot asphaltum by the manufacturer to prevent the deteriorating effects of corrosion and to fill up any sand holes, flaws or other defects that may have occurred in manufacture. Extra heavy

pipe is also coated in this manner to prevent corrosion, however, it is often left plain so that any defects may be discovered and remedied.

Pipe for Corrosive Wastes.—The rapid growth of the use of acids and other corrosives in industrial work, as well as the increasing number of schools, colleges, and hospitals containing chemical laboratories, make more necessary a knowledge of this special plumbing requirement.

Among industrial users, the most common are battery service stations, photo-engravers, manufacturing jewelers, and those industries which manufacture enameled or plated articles and therefore must use acids for cleaning the material.

Several kinds of pipe are used to meet the severe requirements of drainage systems for corrosive wastes, such as

1. Non-corrosive metal.
2. Lead lined.

Non-Corrosive Pipe.—An example of non-corrosive pipe is Duriron pipe illustrated in fig. 6,866. This pipe may be cut with a cold chisel and hammer, just like cast iron soil pipe, but the metal is so hard that the chisel will make only a slight scratch on the pipe. Running around the pipe two or three times with the chisel, using about the same weight hammer blows as with cast iron will cause the pipe to break clean.

A pipe cutter having a coil spring above the specially hardened cutter wheel will save much time on a job.

In making joints on Duriron pipe, asbestos rope, at least 85% pure, should be used in place of hemp or oakum in order to make an acid proof joint, and the lead should be poured at

as low temperature as possible. If too hot, the bell or hub may be cracked while caulking.

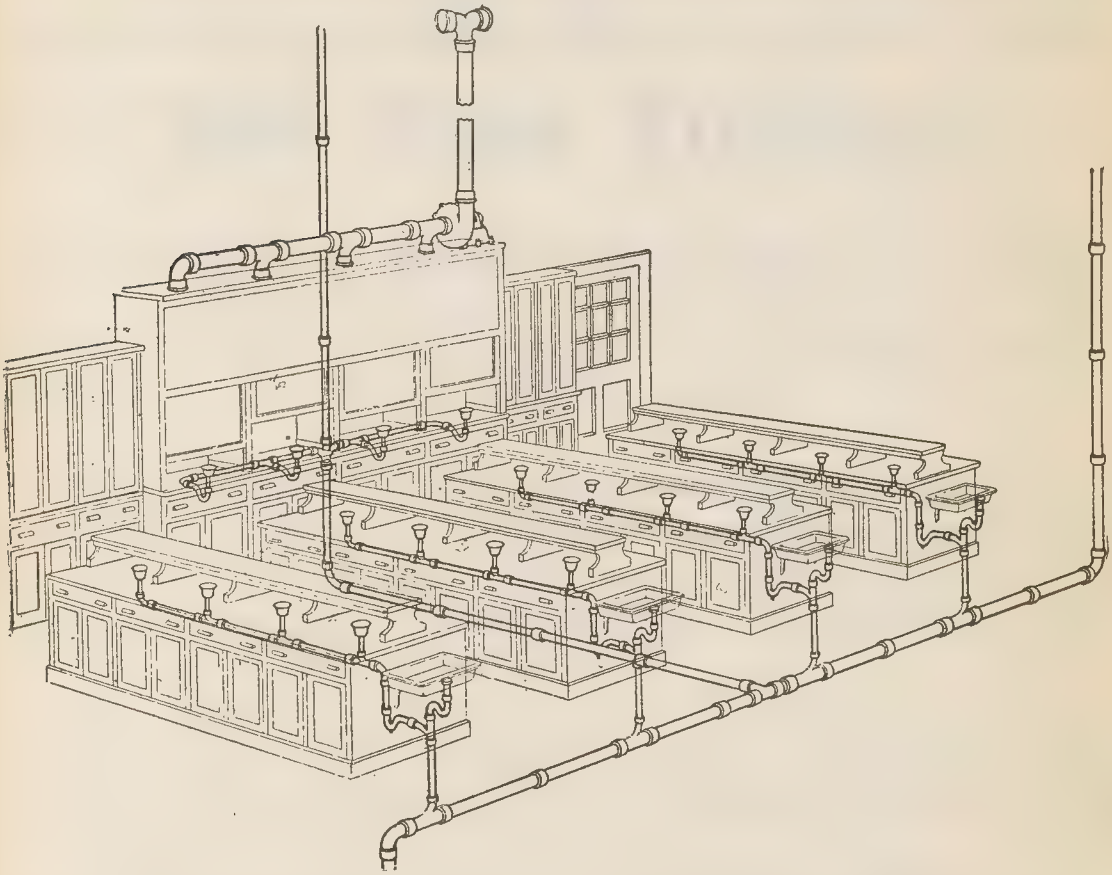


Fig. 6.866.—Duriron laboratory equipment. The pipe and fittings are made from an alloy of iron which has been in use for a number of years for chemical plant equipment but has only recently become available in the form of soil pipe and fittings. It is a homogeneous metal of about the same weight as cast iron. Though requiring no coating or treatment it has an appearance somewhat similar to galvanized pipe. While it is not absolutely proof against all acids, it is claimed to be so nearly so that it may be expected to outlast any building in which it is installed except under the most severe conditions in industrial work.

Lead Lined Cast Iron Pipe.—This pipe is sometimes used in places where acids enter the drainage system. In making up a joint with lead lined pipe, the pipe itself should be cut off at a point that will allow for heating the lead over the end

of the pipe. When placed in the bell the hot lead will make a perfect joint, and the iron will be protected from contact with the acids.

Lead-lined pipe may be secured in two forms, screwed and flanged. The former is cut and installed just like steel pipe.

CHAPTER 116

Soil Pipe Fittings

Specifications for Soil Pipe and Fittings.—The following details regarding the manufacture and dimensions of soil pipe and fittings represent standard practice and is here given by courtesy of The Central Foundry Company.

Quality of Iron.—The iron composing the pipe and fittings must be of such composition and the condition of manufacture so maintained that the resulting pipe and fittings are of a compact, close grained metal and are not hard, brittle nor difficult to cut with file or chisel.

The constituents of the iron must be so regulated by utilizing raw material of known chemical composition and by calculating the chemical constituents of the charges daily that the iron maintains uniform physical characteristics.

The following limits of analyses of the castings are required: The silicon in no case will be less than 1.85 nor the sulphur above .11.

With	silicon	1.85	to	1.90	the	sulphur	must	not	be	above	.06
"	"	1.90	"	1.95	"	"	"	"	"	"	.07
"	"	1.95	"	2.00	"	"	"	"	"	"	.08
"	"	2.00	"	2.05	"	"	"	"	"	"	.09
"	"	2.05	"	2.15	"	"	"	"	"	"	.10
"	"	2.15	and over	the		"	"	"	"	"	.11

The manganese content shall be such as to give the iron proper closeness of grain without brittleness, and must not be below .20 nor above .60. The content of phosphorus must not exceed 1.10. The iron used must be of good quality and contain no admixture of cinder iron or other inferior metal.

WEIGHTS OF FITTINGS

Only the staple fittings are shown. From the data herewith the weights of other fittings may be calculated.

Fittings, Size	2″	3″	4″	5″	6″	3x2″	4x2″	4x3″	5x2″	5x3″	5x4″	6x2″	6x3″	6x4″	6x5″
Special Reducing ¼ Bends	......	......	......	......	......	9¼	......	......	......	......	18	......	......	22½	......
¼ Bends with H. H. Inlet.	9¼	14	19½	......	......	13	17½	18½	21½	22½	23½	26	27	28	......
¼ Bends with Low-Heel Inlet..................	9½	14½	20½	......	......	13½	18	19¼	22½	23½	24½	27	28	29½	......
¼ Bends with Side Inlet...	11	16	22	......	......	14½	19	20½	23	24½	26	27½	29	30½	......
Double ¼ Bends.........	10¾	16¼	23	29	36	15½	20½	22	......	......	......	......	......	......	......
Special Reducing ⅛ Bends	......	......	......	......	......	......	......	10¾	......	......	14¼	......	......	17¼	......
Milwaukee or Reilly Bds.	......	......	31½	38½	45½	......	29	......	......	......	37½	......	......	43½	......
Milwaukee or Reilly Bds. with Foot Rest.........	......	......	33	40	47½	......	30½	......	......	......	39	......	......	45½	......
Return Bends, Dble Hub..	10	15¼	22	28	35	......	......	......	......	......	......	......	......	......	......
¼ Bends, Double Hub....	8	11¾	16¼	20½	25	......	......	......	......	......	......	......	......	......	......
⅛ Bends, Double Hub....	6¾	10	13½	16½	19¾	......	......	......	......	......	......	......	......	......	......
⅟₁₆ Bends, Double Hub....	6¼	9	12¼	14¾	17¼	......	......	......	......	......	......	......	......	......	......
Double Y Branches........	14¾	23	32	41½	52	17¾	21	26½	24	29½	35½	27	33	39	45½
Double ½ Y Branches....	13½	20½	28½	35½	43½	16¾	19¾	24	23	27	31½	25½	30	35	39
Double Inverted Y Bchs.	15¼	23½	33	42½	53½	18¾	22½	27½	25½	31	37	29	34½	41	47
Crosses................	13¼	19¾	27	33½	40½	16½	19½	23	22½	26	30	25½	29½	33½	37
Sanitary Crosses.........	14¾	22	29½	36½	44½	17¾	21	25	24	28	33	27	31½	36	40
Tapped Crosses, Tapped up to 2″	10¼	......	......	......	......	13¼	16½	......	19¼	......	......	22½	......	......	......
Tapped Sanitary Crosses, Tapped up to 2″.......	10¾	......	......	......	......	13¾	17	......	19¾	......	......	23	......	......	......
T Branches, all hubs......	10¼	15¼	21	26½	32	13¼	16½	18¾	19¼	21½	24	22	24½	27	29½
Combination Y and ⅛ Bends with 2″ Vent.....	14¾	......	32	......	......	......	21½	26½	......	......	......	......	......	......	......
S. Traps with Hub Vent...	14¾	24	35	47	60½	23	32½	33½	43½	45	46	56½	58	59	60
¾ S. Traps with Hub Vent	14	22½	33	44	56½	21½	30½	31½	40½	42	43	52½	54	55	56
½ S. or P. Traps with Hub Vent................	13½	21½	31	41	52½	20½	28½	29½	37½	39	40	48½	50	51	52

Weights.—In general, the weights and measurements of pipe and fittings shall be taken as those of plain uncoated pipe. All weights are in pounds.

WEIGHTS OF FITTINGS—*Table Continued*

Fittings / Size	2″	3″	4″	5″	6″	3x2″	4x2″	4x3″	5x2″	5x3″	5x4″	6x2″	6x3″	6x4″	6x5″
Running Traps with Dble Hub Vent	17½	27½	38½	50	63	25	34	36	43½	46	48½	55	57½	60	61½
Running Traps with Single Hub Vent	14½	23	33	43½	55½	22	31	32	40½	41½	43	51½	52½	54	55
Short Tapped Increasers, Tapped up to 2″	4	....	....	....	....	5¼	7	..	8¼	....	....	9½	....	....	....
Plugs	1½	2¾	4	5	6½	....	....	....	....	....	....	....	....	....	....
Pipe Rests	3¼	4½	5¾	7½	9¼	....	....	....	....	....	....	....	....	....	....
S Traps	12	20	30	40½	53½	....	....	....	....	....	....	....	....	....	....
¾ S Traps	11¼	18½	27½	37½	49	....	....	....	....	....	....	....	....	....	....
½ S or P Traps	10½	17¼	25½	34½	45	....	....	....	....	....	....	....	....	....	....
Running Traps	11¾	19	27½	37	48	....	....	....	....	....	....	....	....	....	....
S Traps with Hand Hole & Cover	13	21½	32	43	56½	....	....	....	....	....	....	....	....	....	....
¾ S Traps with Hand Hole and Cover	12¼	20	29½	40	52	....	....	....	....	....	....	....	....	....	....
½ S or P Traps with Hand Hole and Cover	11½	18¾	27½	37	48	....	....	....	....	....	....	....	....	....	....
Running Traps with Hand Hole and Cover	12¾	20½	29½	39½	51	....	....	....	....	....	....	....	....	....	....
Running Traps with Y Branch and Vent	....	....	45½	60	76½	....	....	....	....	....	....	55	....	66	....

All weights are in pounds.

The table gives the weights of staple fittings. From the data herewith given the accompanying weights of other fittings may be calculated.

Tests of Material.—From each heat at intervals of not more than four hours' operation there shall be made three bars, test being based on the average results of these three bars.

WEIGHTS OF FITTINGS—*Offsets*

Offsets—to offset.	2″	4″	6″	8″	10″	12″	14″	16″	18″	20″	22″	24″			
2″ Regular	7	8	9	9¾	10¾	11¾	12¾	13¾	14½	15½	16½	17½			
3″ "	10¼	12	13¼	14¾	16	17½	18¾	20½	21½	23	24½	26			
4″ "	13¾	16¼	18	19¾	21½	23½	25	27	29	30½	32½	34			
5″ "	17¼	20½	22½	25	27	29½	31½	33½	36	38	40½	42½			
6″ "	21	24½	28	30½	33	35½	38½	41	43½	46½	49	51½			
2″ ⅛ Bend	7	8¼	9½	10¾	12	13¼	14¾	16	17¼	18½	19¾	21			
3″ " "	10¼	12	14	15¾	17¾	19½	21½	23½	25½	27	29	31			
4″ " "	13¾	16¼	18¾	21	23½	26	28½	31	33½	36	38½	41			
5″ " "	17¼	20½	23½	26½	29½	32½	35½	38½	41½	44½	47½	50½			
6″ " "	21	24½	28	31½	35½	39	42½	46	49½	53½	57	60½			

WEIGHTS OF FITTINGS—*Extension Pieces*

Extension Pieces Size—Length.		4″	6″	8″	10″	12″	14″	16″	18″	20″	22″	24″			
2″		4¾	5¾	6½	7½	8½	9¼	10¼	11¼	12	13	14			
3″		6¾	8¼	9½	10¾	12¼	13½	14¾	16¼	17½	18¾	20½			
4″		9	10¾	12½	14¼	16	17¾	19½	21½	23	25	26½			
5″		10¾	13	15	17¼	19½	21½	24	26	28	30	32½			
6″		12¾	15¼	17¾	20½	23	25½	28	30½	33½	36	38½			

Should the dimensions of the three bars differ from those here given, a proper allowance shall be made in the results of the test. Specimen bars of the metal used, each being 26″ long, 2″ wide and 1″ thick, shall be made.

WEIGHTS OF FITTINGS—*Cleanouts*

Fittings—Size.	2″	3″	4″	5″	6″	3x2″	4x2″	4x3″	5x2″	5x3″	5x4″	6x2″	6x3″	6x4″	6x5″
T Cleanouts, Rd., Hand Hole and Iron Cover....	8¼	12¾	17½	22½	28										
T Cleanouts, Brass Trap Screw on Branch.......	8¼	12¾	17½	22½	28										
Y Cleanouts, Brass, Trap Screw on Branch.......	9	14½	20½	27½	35										
Y Cleanouts, Brass, Trap Screw on Main.........	9	14½	20½	27½	35										
Y & ⅛ Bend Cleanouts, B. T. S. on Main......	10	16¼	23½	31	40										
Threaded Iron Ferrules with B. T. S...........	1½	2¾	4	5	6½										

WEIGHTS OF FITTINGS—*Bends*

Long Fittings, Size Length in clear.	2″	3″	4″	5″	6″										
¼ Bends 12″...........	10¼	15¼	21	26	32										
" " 18″...........	13	19¼	26	32½	39½										
" " 24″...........	15¾	23½	31	39	47½										
" " 30″...........	18½	27½	36½	45½	55										
⅛ Bends 12″...........	9	13¼	17¾	22	26½										
" " 18″...........	11¾	17¼	23	28½	34½										
" " 24″...........	14½	21½	28½	35	42										
" " 30″...........	17¼	25½	33½	41½	49½										

The bars when placed flat-wise upon supports 24″ apart and loaded in the center shall support a load of not less than 2,000 lbs. and show a deflection of not less than 0.30″ before breaking, or if preferred, tensile bars shall be made which will show a breaking point of not less than 20,000 lbs. per sq. in.

WEIGHTS OF FITTINGS—*Long T Branches, Crosses*

Long Fittings—Size Length in clear.	2″	3″	4″	5″	6″	3x2″	4x2″	4x3″	5x2″	5x3″	5x4″	6x2″	6x3″	6x4″	6x5″
T Branches 18″	14¼	20½	27	33	39										
" 24″	17	25	32½	39½	46½										
" 30″	19¾	29	37½	46	54										
" 36″	22½	33	43	52	62										
Sanitary T Branches 18″	15	21½	28½	34½	40½										
" " " 24″	17¾	26	33½	41	48½										
" " " 30″	20½	30	39	47½	56										
" " " 36″	23½	34	44	54	64										
Y Branches 18″	15	22	29½	36	43½										
" " 24″	17¾	26	34½	42½	51										
" " 30″	20½	30	40	49	58½										
" " 36″	23½	34	45	55½	66½										
Tapped T Branches Tap'd up to 2″ 18″	12¾	......	......	......	......	17¾	23	......	27½	......	......	32½	......	......	......
" " " " 24″	15½	......	......	......	......	22	28	......	34	......	......	40	......	......	......
Tap'd. San. Tee Bch., Tap'd. up to 2″ 18″	13	......	......	......	......	18	23	......	28	......	......	32½	......	......	......
" " " " 24″	15¾	......	......	......	......	22	28½	......	34	......	......	40	......	......	......
Tapped Crosses, Tapped up to 2″ 18″	14¼	......	......	......	......	19¼	24½	......	29	......	......	34	......	......	......
" " " " 24″	17	......	......	......	......	23½	29½	......	35½	......	......	41½			
Tapped San. Crosses, Tap'd. up to 2″ 18″	15	......	......	......	......	19¾	25	......	29½	......	......	34½			
" " " " 24″	17¾	......	......	......	......	24	30	......	36	......	......	42			

Testing of Pipe and Fittings.—All pipe and fittings must be tested to a hydrostatic pressure of not less than fifty pounds to the square inch before coating. Any casting showing defects under this hydrostatic test shall be promptly broken and returned to the cupola.

Coating.—Where pipe or fittings are to be coated the method employed must be as

WEIGHTS OF FITTINGS—*Increasers, Bends, Etc.*

Long Fittings—Size. Length in clear	2″	3″	4″	5″	6″	3x2″	4x2″	4x3″	5x2″	5x3″	5x4″	6x2″	6x3″	6x4″	6x5″
Increasers, Tap'd. S. I., Tapped up to 2″ . . . . 24″							20½	22							
" " " " 30″											33½				
" " " " 36″														46	
¼ Bends Dble. Spig. 18″	12¼	18¼	24½												
" " " 24″	15	22¼	30												
Increasers, 24″							18¾	20			25			29	
" 30″							24	25½			31½			36½	
" 36″							29	30½			38			44	
" 48″							39½	41			51			59½	
Tap'd. Increasers, Tap'd. up to 2″. 24″							19								
" " " " 30″							24½								
" " " " 36″							29½								
" " " " 48″							40								
Side Inlets on Side of San. Ts, Ys, San. Crosses & Double Ys, add to reg. Fitting weight	4¼	5¾	7¼	8¼	9¼										

Fittings Size	4 x 2 x 4″	4 x 3 x 4″	5 x 4 x 4″	6 x 4 x 4″
Special Reducing Sanitary T Branch	18	21	23½	27½
" " Y Branch	21½	23	26½	29

follows: The coating shall be of coal tar pitch varnish. The varnish shall be made from coal tar. This material must contain sufficient oil to make a smooth coating, tough and tenacious when cold, and not brittle nor having any tendency to scale off.

Each casting shall be heated to a temperature of 300 degrees F. immediately before it is dipped and shall possess not less than this temperature at the time it is put in the bath. The pipe and fittings must be uniformly heated so that the coating throughout has the proper qualities.

Each casting shall remain in the bath at least two minutes. The varnish shall be heated to 300 degrees F. and shall remain at this temperature during the time the casting is immersed.

Fresh pitch and oil shall be added when necessary to keep the mixture at the proper consistency, and the vat shall be emptied of its contents and refilled with fresh pitch whenever the accumulation of sand or carbonaceous matter renders this desirable, as can be seen by the adhering solids to the under side or lower ends of the castings. After being coated the pipe and fittings shall be carefully drained of the surplus varnish.

Weight of Soil Pipe.—The regular length of pipe shall be such as to lay 5 ft. Including hub the average weights shall be not less than the following:

Size, Inches	Single Hub		Double Hub
	Per 5′ Length Pounds	Per Foot, Including Hub, Pounds	Per 5′ Length Pounds
2	27½	5½	27½
3	47½	9½	47½
4	65	13	65
5	85	17	85
6	100	20	100

Individual lengths of pipe and fittings may weigh 5% less than designated above, but only when the average weight of a given size and make of pipe and fittings selected at random is not less than above shown.

Inspection.—All pipe and fittings must be carefully examined for defects, and sounded with a hammer before shipment. No filling with metal, cement or other material or so-called burning on of iron is to be permitted. The castings must be sound and free from cracks, sand holes, blow holes and cold shots.

Records.—Permanent records of the daily foundry practice

shall be kept at each foundry manufacturing soil pipe and fittings in conformity with these specifications.

These records must include, among other things, the analyses and the quantities of the irons which go to make up the daily cupola charges, as well as the results of the breaking loads and deflections and average daily analysis of the test bars made in compliance with the specifications.

Since the purpose of the records is to permit verification of the methods of manufacture in accordance with the specifications, they must be in permanent form and available to those entitled to consult them.

Inside Diameter.—The inside diameter of the barrel of any pipe or fittings or branch thereof shall not be less at any point than ⅛″ less than the nominal size of same.

Outside Diameter.—The outside diameter of the barrel of pipe and fittings shall be ½″ greater than its nominal inside diameter. A variation in the outside diameter of ⅛″ above or below these figures will be permitted.

Wall Thickness.—All pipe and fittings must be of uniform wall thickness and must present at the hub and spigot ends a true circle. A variation of 1/16″ less than the figures below will be permitted, but only when the actual weight is not less than the variation of the marked or estimated weight as set forth:

WALL THICKNESS

Barrel	Body of Hub	Through Bead of Hub	Through Bead at Spigot End
¼″	5/16″	½″	7/16″

The wall of all pipe and fittings must be smooth and free from fins and ridges which restrict the full effective area. All pipe must be thoroughly milled and free from adhering sand.

Hubs.—The depth of hub shall be the distance, measured parallel to the axis of the opening, from the end of the hub to the beginning of any offset or change of direction of the inside wall of same. The depth of hubs shall not be less than as follows:

Size of pipe,	2″	3″	4″ to 6″
Depth of hub,	2¼″	2½″	2¾″

The spigot end shall telescope not less than as follows:

2″	3″	4″ to 6″
2½″	2¾″	3″

Hub bead shall have at its greatest diameter a width as follows:

2″	3″	4″ to 6″
⅝″	11/16″	¾″

The inside diameter of the hubs shall be:

2″	3″	4″	5″	6″
3 3/16″	4 3/16″	5 3/16″	6 3/16″	7 3/16″

A variation in these diameters of 1/16″ will be permitted.

Spigots.—The outside diameter of the spigot bead must be 2⅞″ on 2″; 3⅞″ on 3″; 4⅞″ on 4″; 5⅞″ on 5″, and 6⅞″ on 6″. A variation in these diameters of 1/16″ will be permitted.

Caulking Room.—The spigot end, including bead, of every fitting must be straight without offset or change in direction for at least 4″, except that on 3″ bends this may be 3½″, and on 2″ bends, 3″; on all traps this must be at least 5″.

The laying length of a fitting is the over-all length less the telescoping.

Radius of Fittings.—The standard radii for bends, offsets and traps are given on the next page.

BENDS

All Degrees	Size				
	2″	3″	4″	5″	6″
Radius, Regular..........	3″	3½″	4″	4½″	5″
" Short Sweep....	5″	5½″	6″	6½″	7″
" Long Sweep......	8″	8½″	9″	9½″	10″

The given radii of regular bends are the same as those for sanitary Ts, combination Y and ⅛ bends, upright Ys and vent branches. Bends radii shall be to center line of fitting.

Offsets.—The radii of the bends on offsets, both regular and ⅛ bend offsets, shall be as follows:

Diameter,	2″	3″	4″	5″	6″
Radius,	2″	2½″	3″	3½″	4″

The angle of the bends of regular offsets shall not be more than 76 degrees.

The angle of bends of eighth bend offsets shall be 45 degrees.

Traps.—The radii of all traps shall be as follows:

Diameter,	2″	3″	4″	5″	6″
Radius,	2″	2½″	3″	3½″	4″

The caulking room at spigot end shall not be less than 5″.

The seal to be not less than 2½″.

Combination Y and Eighth Bends and Upright Y's.—These are produced by combining a regular full Y with a regular eighth bend less the hub of the branch of the former and less the spigot end of the latter.

NOTE.—***In laying out any drainage installation*** the aim should be to secure proper drainage with the simplest arrangement of piping and least number of joints. The more usual form of fittings should be specified, such as are easily obtainable especially in localities remote from large supply houses.

Laying Lengths.—The laying lengths as given in the following tables is *the overall length less the telescoping.*

BRANCH FITTINGS

All Laying Lengths are in Inches	Size					All sizes with Branches of Diameter			
	2″	3″	4″	5″	6″	2″	3″	4″	5″
Tees	9	10	11	12	13	9	10	11	12
Tapped Tee	9	9	9	9	9	9			
Sanitary Tee	9	10	11	12	13	9	10	11	12
Tapped Sanitary Tee	9	9	9	9	9	9			
Y	9	10½	12	13½	15	9	10½	12	13½
½ Y	9	10	11	12	13	9	10	11	12
Inverted Y	11	12½	14	15½	17	11	12½	14	15½
Tapped Inverted Y	11	11	11	11	11	11			
Comb. Y and ⅛ Bend	9	10½	12	13½	15	9	10½	12	13½
Upright Y	9	10½	12	13½	15	9	10½	12	13½
Vent Branch	9	10	11	12	13	9	10	11	12
Tapped Vent Branch	9	9	9	9	9	9			

MISCELLANEOUS FITTINGS

All Laying Lengths are in Inches	Size				
	2″	3″	4″	5″	6″
Reducers	5	5	5	5	5
Increasers	9	9	9	9	9
Tapped Increasers	9	9	9	9	9
Single Hub	½	½	½	½	½
Double Hub	1	1	1	1	1

Properties of Cast Iron Soil Fittings.—The following tables of dimensions, thicknesses and weights are compiled with the requirements of the foregoing specifications as a basis. The reference letters on the illustrations correspond to those in the tables.

DIMENSIONS FOR BENDS

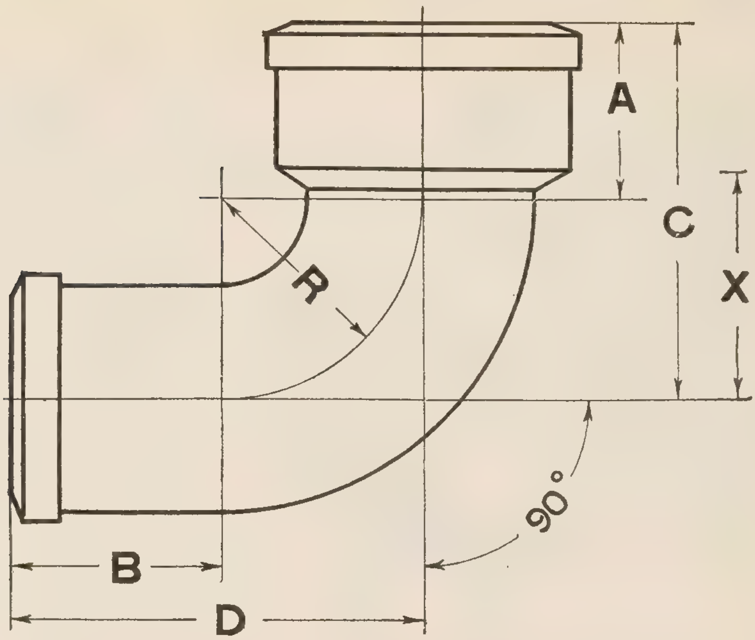


Fig. 6,867.—Dimensional drawing for tables of ¼ bend, short sweep ¼ bend, and long sweep ¼ bend.

1-4 Bend

Size In.	A	B	C	D	R	X	Wgt. Lbs.
2	3	3	6	6	3	3½	6¾
3	3¼	3½	6¾	7	3½	4	10¼
4	3½	4	7½	8	4	4½	15
5	3½	4	8	8½	4½	5	19
6	3½	4	8½	9	5	5½	23½

Short Sweep 1-4 Bend

2	3	3	8	8	5	5½	8¼
3	3¼	3½	8¾	9	5½	6	12½
4	3½	4	9½	10	6	6½	17¾
5	3½	4	10	10½	6½	7	22½
6	3½	4	10½	11	7	7½	27½

Long Sweep 1-4 Bend

2	3	3	11	11	8	8½	10¼
3	3¼	3½	11¾	12	8½	9	15¾
4	3½	4	12½	13	9	9½	22
5	3½	4	13	13½	9½	10	27½
6	3½	4	13½	14	10	10½	33½

DIMENSIONS FOR BENDS

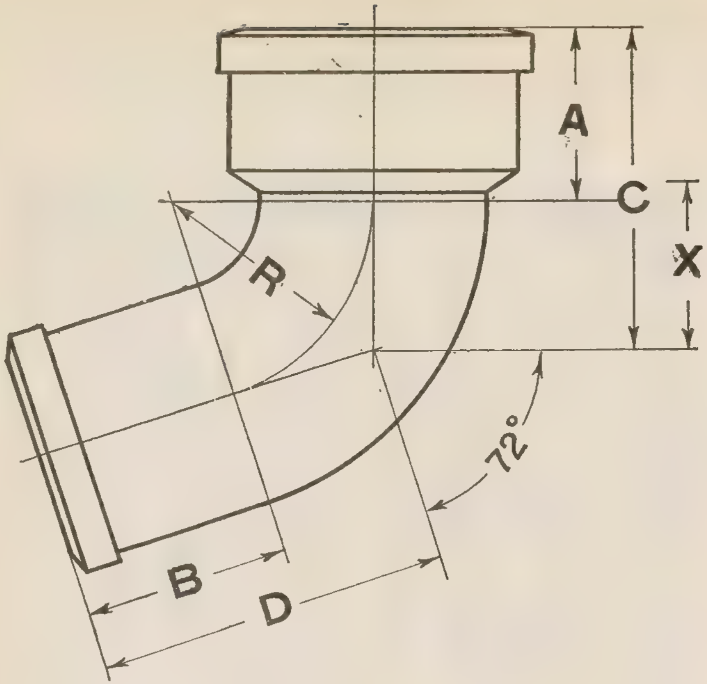


FIG. 6,868.—⅕ *bend.*

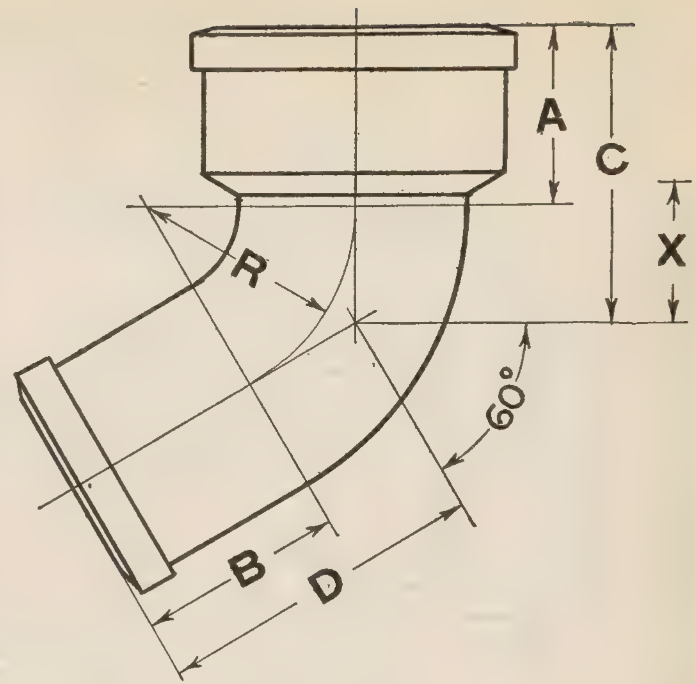


FIG. 6,869.—⅙ *bend.*

1-5 Bend

Size In.	A	B	C	D	R	X	Wgt. Lbs.
2	3	3	5 3/16	5 3/16	3	2 11/16	6¼
3	3¼	3½	5 13/16	6 1/16	3½	3 1/16	9¾
4	3½	4	6 7/16	6 15/16	4	3 7/16	13¾
5	3½	4	6¾	7¼	4½	3¾	17½
6	3½	4	7⅛	7⅝	5	4⅛	21½

1-6 Bend

Size In.	A	B	C	D	R	X	Wgt. Lbs.
2	3	3	4¾	4¾	3	2¼	6
3	3¼	3½	5¼	5½	3½	2½	9¼
4	3½	4	5 13/16	6 5/16	4	2 13/16	13
5	3½	4	6⅛	6⅝	4½	3⅛	16½
6	3½	4	6⅜	6⅞	5	3⅜	20

DIMENSIONS FOR BENDS

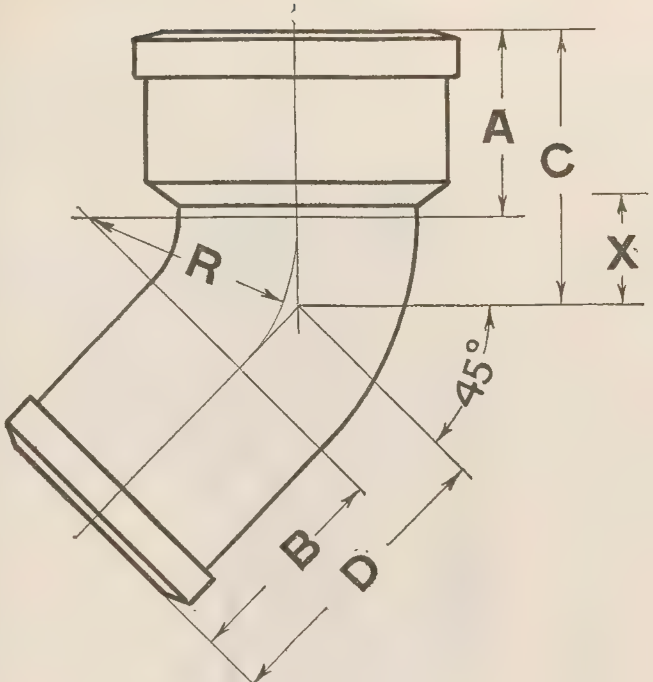


FIG. 6,870.—$\frac{1}{8}$ *bend.*

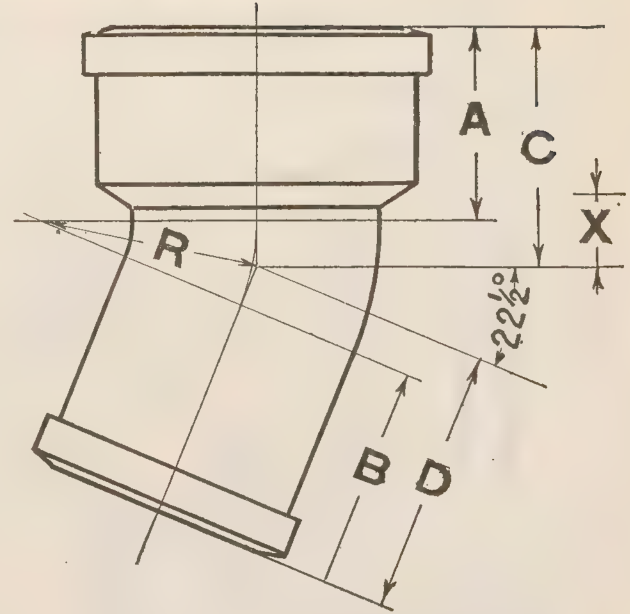


FIG. 6,871.—$\frac{1}{16}$ *bend.*

1-8 Bend

Size In.	A	B	C	D	R	X	Wgt. Lbs.
2	3	3	$4\frac{1}{4}$	$4\frac{1}{4}$	3	$1\frac{3}{4}$	$5\frac{1}{2}$
3	$3\frac{1}{4}$	$3\frac{1}{2}$	$4\frac{15}{16}$	$4\frac{15}{16}$	$3\frac{1}{2}$	$1\frac{15}{16}$	$8\frac{1}{2}$
4	$3\frac{1}{2}$	4	$5\frac{3}{16}$	$5\frac{11}{16}$	4	$2\frac{3}{16}$	$12\frac{1}{4}$
5	$3\frac{1}{2}$	4	$5\frac{3}{8}$	$5\frac{7}{8}$	$4\frac{1}{2}$	$2\frac{3}{8}$	$15\frac{1}{4}$
6	$3\frac{1}{2}$	4	$5\frac{9}{16}$	$6\frac{1}{16}$	5	$2\frac{9}{16}$	$18\frac{1}{4}$

1-16 Bend

Size In.	A	B	C	D	R	X	Wgt. Lbs.
2	3	3	$3\frac{5}{8}$	$3\frac{5}{8}$	3	$1\frac{1}{8}$	5
3	$3\frac{1}{4}$	$3\frac{1}{2}$	$3\frac{15}{16}$	$4\frac{3}{16}$	$3\frac{1}{2}$	$1\frac{3}{16}$	$7\frac{3}{4}$
4	$3\frac{1}{2}$	4	$4\frac{5}{16}$	$4\frac{13}{16}$	4	$1\frac{5}{16}$	$10\frac{3}{4}$
5	$3\frac{1}{2}$	4	$4\frac{3}{8}$	$4\frac{7}{8}$	$4\frac{1}{2}$	$1\frac{3}{8}$	$13\frac{1}{4}$
6	$3\frac{1}{2}$	4	$4\frac{1}{2}$	5	5	$1\frac{1}{2}$	$15\frac{3}{4}$

DIMENSIONS FOR BENDS

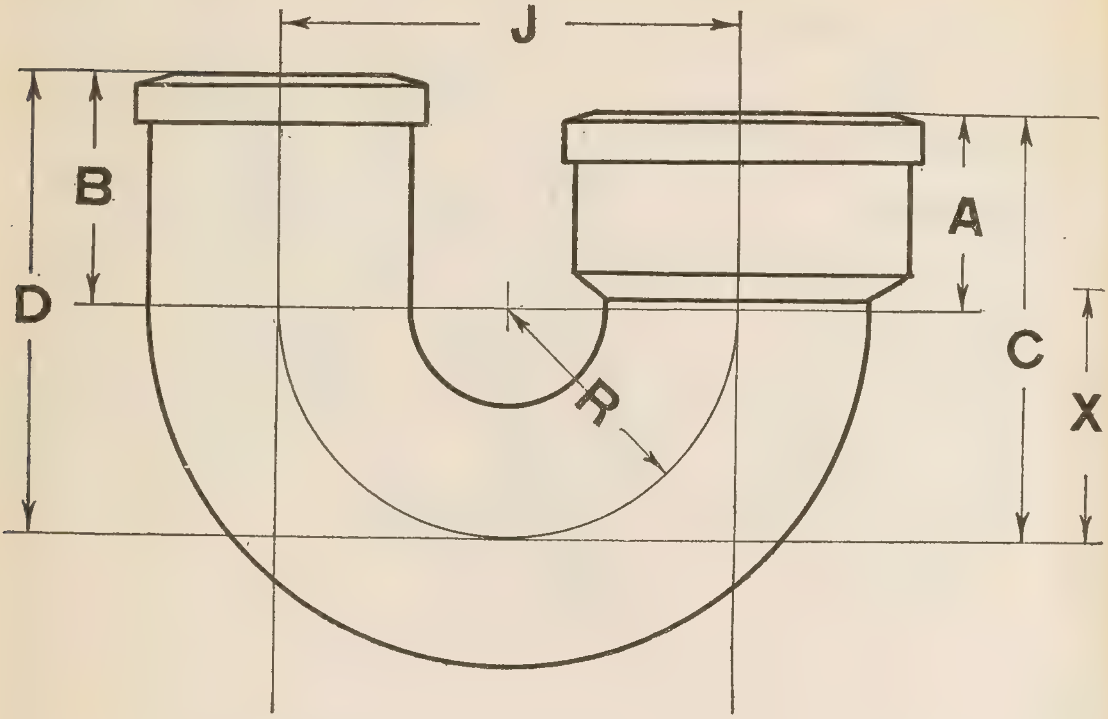


FIG. 6,872.—***Return or ½ bend.***

Return or 1-2 Bend

Size In.	A	B	C	D	J	R	X	Wgt Lbs.
2	3	3	6	6	6	3	3½	8¾
3	3¼	3½	6¾	7	7	3½	4	14
4	3½	4	7½	8	8	4	4½	20¼
5	3½	4	8	8½	9	4½	5	26½
6	3½	4	8½	9	10	5	5½	33½

NOTE.—***Return bends*** are made not only with regular bell and spigot end as shown in the illustration above, but also with double bell, and with double spigot ends, thus making available several types to meet any special makeup conditions.

DIMENSIONS FOR Y BRANCHES

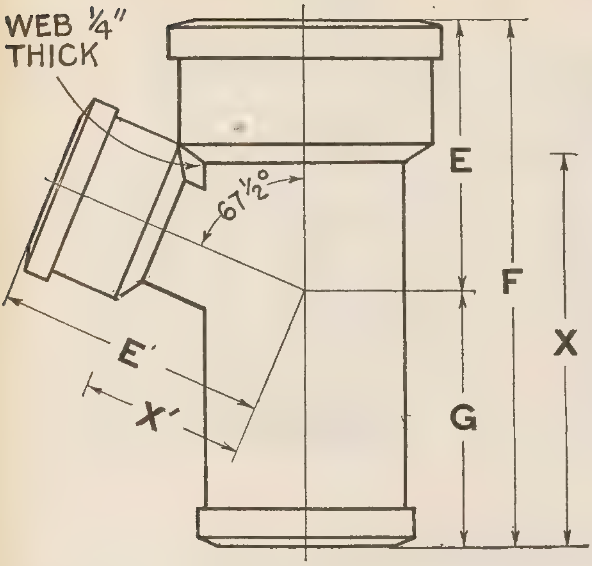


FIG. 6,873.—½ *Y branch.*

1-2 "Y" Branch

Size In.	E	E′	F	G	X	X′	Wgt. Lbs.
2	5¼	5¼	11½	6¼	9	2¾	10¼
3	6¼	6¼	12¾	6½	10	3½	15½
4	7¼	7¼	14	6¾	11	4¼	21½
5	8	8	15	7	12	5	27½
6	8¾	8¾	16	7¼	13	5¾	34
3x2	5⅝	5¾	11¾	6⅛	9	3¼	13½
4x2	6⅛	6¼	12	5⅞	9	3¾	16½
4x3	6⅝	6¾	13	6⅜	10	4	19
5x2	6⅜	6⅞	12	5⅝	9	4⅜	19½
5x3	6⅞	7¼	13	6⅛	10	4½	22
5x4	7⅜	7¾	14	6⅝	11	4¾	25
6x2	6½	7⅜	12	5½	9	4⅞	22½
6x3	7⅛	7⅞	13	5⅞	10	5⅛	25½
6x4	7⅝	8¼	14	6⅜	11	5¼	28½
6x5	8⅛	8½	15	6⅞	12	5½	31

"Y" Branch

Size In.	E	E′	F	G	X	X′	Wgt. Lbs.
2	6¾	6¾	11½	4¾	9	4¼	11
3	8¼	8¼	13¼	5	10½	5½	17
4	9¾	9¾	15	5¼	12	6¾	24
5	11	11	16½	5½	13½	8	31½
6	12¼	12¼	18	5¾	15	9¼	39½
3 x 2	7 9/16	7½	11¾	4 3/16	9	5	14
4 x 2	8 5/16	8¼	12	3 11/16	9	5¾	17¼
4 x 3	9	9	13½	4½	10½	6¼	20½
5 x 2	8 13/16	8 15/16	12	3⅜	9	6 7/16	20
5 x 3	9½	9 11/16	13½	4	10½	6 15/16	23½
5 x 4	10¼	10 7/16	15	4⅜	12	7 7/16	27½
6 x 2	9 5/16	9⅝	12	2 11/16	9	7⅛	23
6 x 3	10	10⅜	13½	3½	10½	7⅝	27
6 x 4	10¾	11⅛	15	4¼	12	8⅛	31
6 x 5	11 7/16	11⅝	16½	5 1/16	13½	8⅝	35

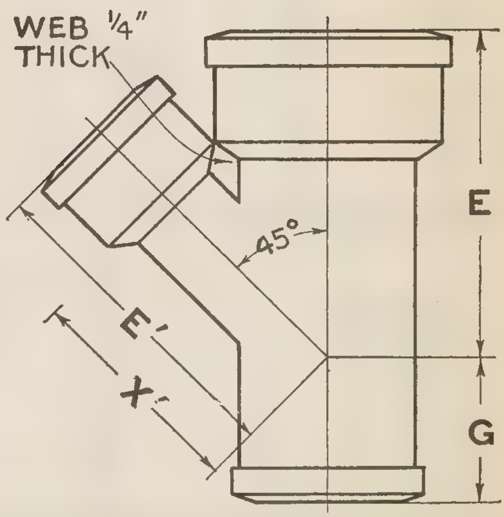
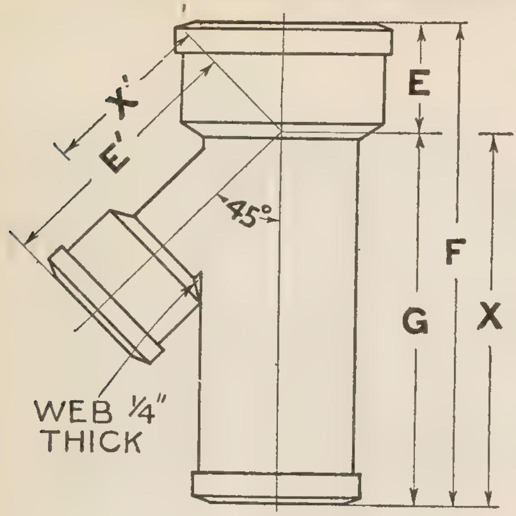


FIG. 6,874.—*Y branch.*

DIMENSIONS FOR Y BRANCHES



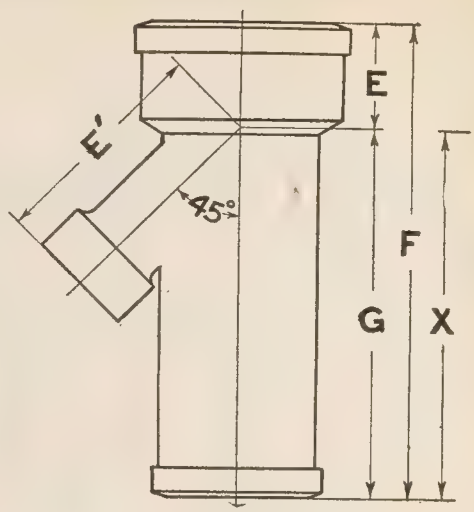


FIG. 6,875.—Inverted Y branch.

FIG. 6,876.—Tapped inverted Y branch.

Inverted "Y" Branch

Size Inches	E	E′	F	G	X	X′	Weight Pounds
2	3½	5⅞	13½	10	11	3⅜	11½
3	4	7⅜	15¼	11¼	12½	4⅝	18
4	4½	8⅞	17	12½	14	5⅞	25½
5	4¾	10⅛	18½	13¾	15½	7⅛	33
6	5	11⅜	20	15	17	8⅜	41½
3x2	3¼	6⅝	13¾	10½	11	4⅛	15
4x2	3 1/16	7⅜	14	10 15/16	11	4⅞	18¾
4x3	3¾	8⅛	15½	11¾	12½	5⅜	22
5x2	2⅝	8 1/16	14	11⅜	11	5 9/16	22
5x3	3 5/16	8 13/16	15½	12 3/16	12½	6 1/16	25½
5x4	4	9 9/16	17	13	14	6 9/16	29½
6x2	2 3/16	8¾	14	11 13/16	11	6¼	25½
6x3	2⅞	9½	15½	12⅝	12½	6¾	29½
6x4	3 9/16	10¼	17	13 7/16	14	7¼	33
6x5	4¼	10¾	18½	14¼	15½	7¾	37

Tapped Inverted "Y" Branch

Size Inches	E	E′	F	G	X	Weight Pounds
2x2	3½	4⅝	13½	10	11	10¼
3x2	3¼	5⅜	13¾	10½	11	13¾
4x2	3 1/16	6⅛	14	10 15/16	11	17½
5x2	2⅝	6 13/16	14	11⅜	11	21
6x2	2 3/16	7½	14	11 13/16	11	24

Tapping boss on fittings may be tapped for 1¼ to 2 inch pipe threads inclusive.

DIMENSIONS FOR Y BRANCHES

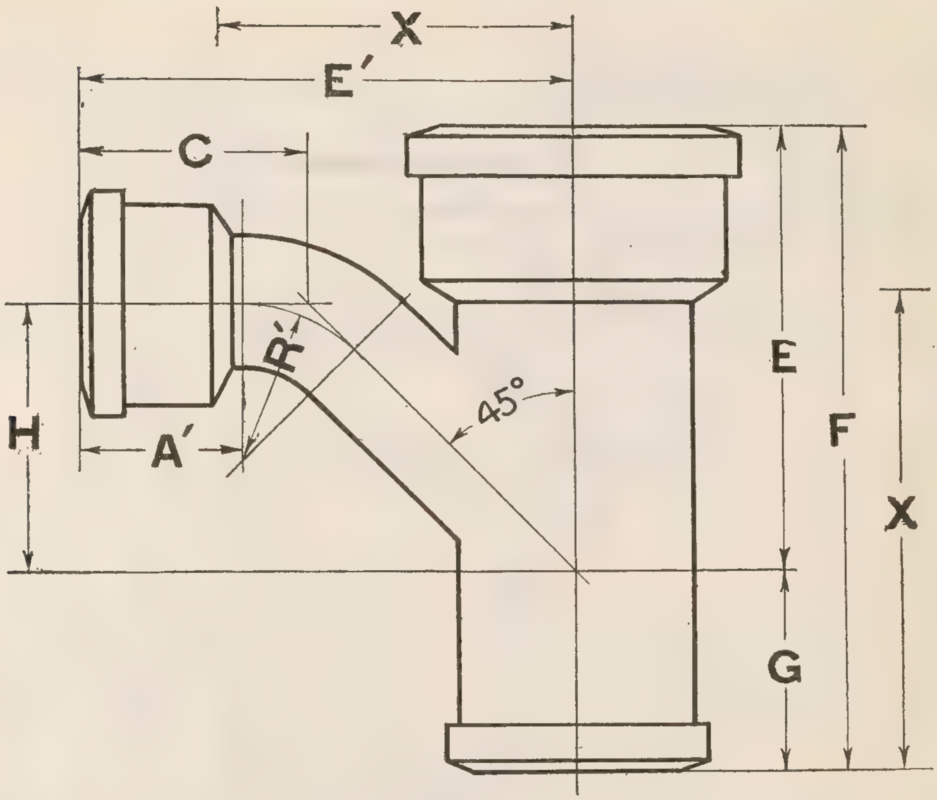


FIG. 6,877.—*Combination Y and 1/8 bend.*

Combination "Y" and 1-8 Bend

Size Inches	A′	C′	E	E′	F	G	H	R	X	X	Weight Pounds
2	3	4 1/4	6 3/4	7 3/4	11 1/2	4 3/4	3 1/2	3	9	5 1/4	12
3	3 1/4	4 11/16	8 1/4	9 1/4	13 1/4	5	4 9/16	3 1/2	10 1/2	6 1/2	18 3/4
4	3 1/2	5 3/16	9 3/4	10 3/4	15	5 1/4	5 9/16	4	12	7 3/4	27
5	3 1/2	5 3/8	11	12	16 1/2	5 1/2	6 5/8	4 1/2	13 1/2	9	35
6	3 1/2	5 9/16	12 1/4	13 1/4	18	5 3/4	7 11/16	5	15	10 1/4	44 1/2
3x2	3	4 1/4	7 9/16	8 1/4	11 3/4	4 3/16	4	3	9	5 3/4	15
4x2	3	4 1/4	8 5/16	8 3/4	12	3 11/16	4 1/2	3	9	6 1/4	18 1/4
4x3	3 1/4	4 11/16	9	9 3/4	13 1/2	4 1/2	5 1/16	3 1/2	10 1/2	7	22 1/2
5x2	3	4 1/4	8 13/16	9 1/4	12	3 3/8	5	3	9	6 3/4	21
5x3	3 1/4	4 11/16	9 1/2	10 1/4	13 1/2	4	5 9/16	3 1/2	10 1/2	7 1/2	25 1/2
5x4	3 1/2	5 3/16	10 1/4	11 1/4	15	4 3/4	6 1/16	4	12	8 1/4	30 1/2
6x2	3	4 1/4	9 5/16	9 3/4	12	2 11/16	5 1/2	3	9	7 1/4	24
6x3	3 1/4	4 11/16	10	10 3/4	13 1/2	3 1/2	6 1/16	3 1/2	10 1/2	8	29
6x4	3 1/2	5 3/16	10 3/4	11 3/4	15	4 1/4	6 9/16	4	12	8 3/4	34
6x5	3 1/2	5 3/8	11 7/16	12 1/2	16 1/2	5 1/16	7 1/8	4 1/2	13 1/2	9 1/2	39

DIMENSIONS FOR Y BRANCHES

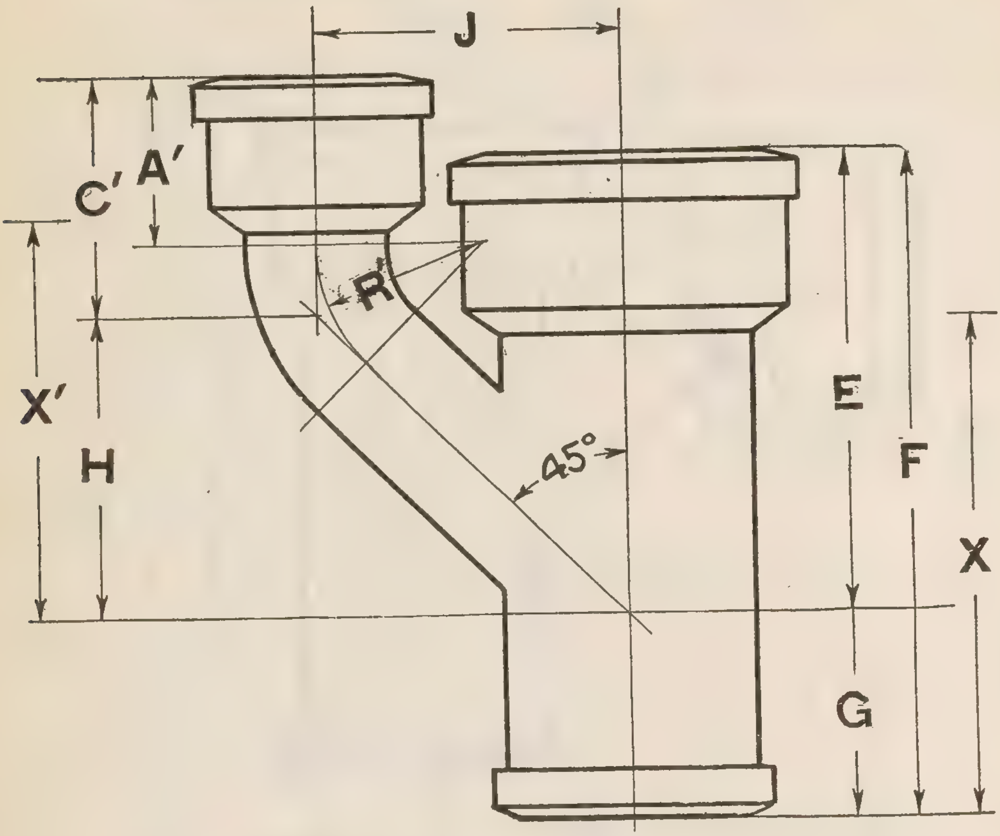


Fig. 6,878.—*Upright Y branch.*

Upright "Y" Branch

Size Inches	A′	C′	E	F	G	H	J	R′	X	X	Weight Pounds
2	3	4¼	6¾	11½	4¾	4½	4½	3	9	6¼	12½
3	3¼	4 11/16	8¼	13¼	5	5½	5½	3½	10½	7 7/16	19½
4	3½	5 3/16	9¾	15	5¼	6½	6½	4	12	8 11/16	28
5	3½	5⅜	11	16½	5½	7½	7½	4½	13½	9⅞	36½
6	3½	5 9/16	12¼	18	5¾	8½	8½	5	15	11 1/16	46
3x2	3	4¼	7 9/16	11¾	4 3/16	5	5	3	9	6¾	15¾
4x2	3	4¼	8 5/16	12	3 11/16	5½	5½	3	9	7¼	18¾
4x3	3¼	4 11/16	9	13½	4½	6	6	3½	10½	7 15/16	23
5x2	3	4¼	8 13/16	12	3⅜	6	6	3	9	7¾	21½
5x3	3¼	4 11/16	9½	13½	4	6½	6½	3½	10½	8 7/16	26½
5x4	3½	5 3/16	10¼	15	4¾	7	7	4	12	9 3/16	31½
6x2	3	4¼	9 5/16	12	2 11/16	6½	6½	3	9	8¼	24½
6x3	3¼	4 11/16	10	13½	3½	7	7	3½	10½	8 15/16	29½
6x4	3½	5 3/16	10¾	15	4¼	7½	7½	4	12	9 11/16	35
6x5	3½	5⅜	11 7/16	16½	5 1/16	8	8	4½	13½	10⅜	40

DIMENSIONS FOR T BRANCHES

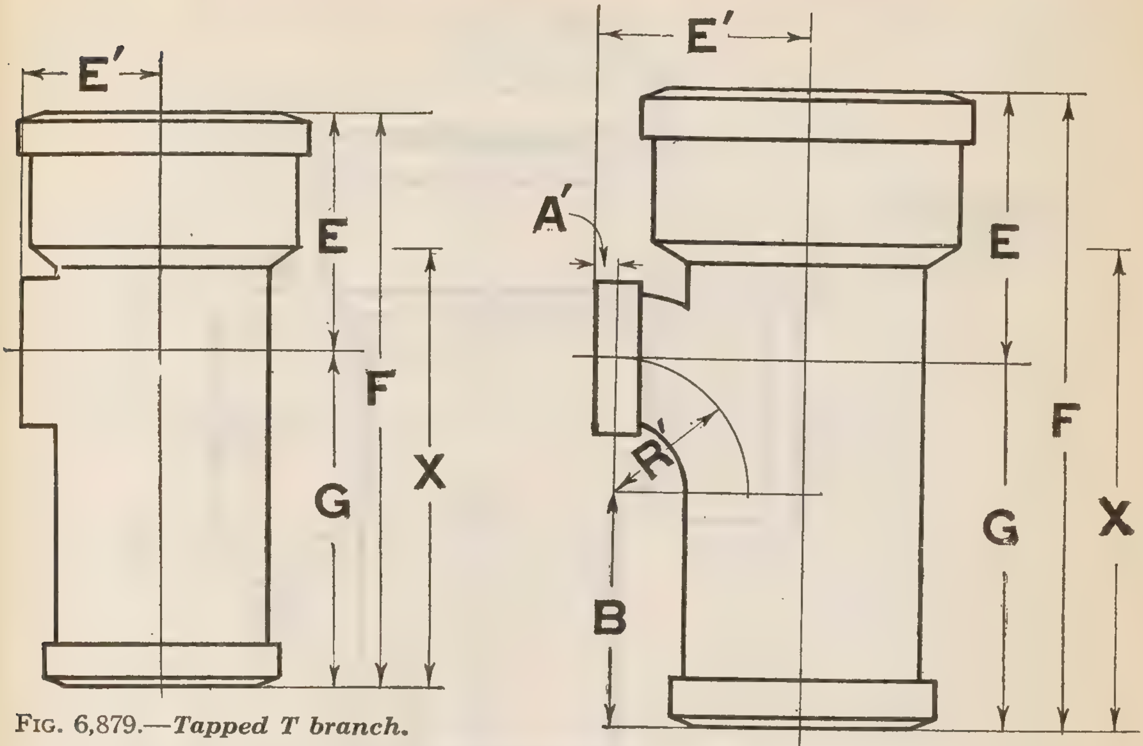


FIG. 6,879.—*Tapped T branch.*
FIG. 6,880.—*Tapped sanitary T branch.*

Tapped "T" Branch

Size Inches	E	E′	F	G	X	Weight Pounds
2x2	4½	2	11½	7	9	8¾
3x2	4¾	2½	11¾	7	9	11¾
4x2	5	3	12	7	9	15
5x2	5	3½	12	7	9	17¾
6x2	5	4	12	7	9	20½

Tapping boss on fittings may be tapped for 1¼ to 2 inch pipe threads inclusive.

Tapped Sanitary "T" Branch

Size Inches	A′	B	E	E′	F	G	R′	X	Weight Pounds
2x2	½	4½	4½	3	11½	7	2½	9	9
3x2	½	4½	4¾	3½	11¾	7	2½	9	12
4x2	½	4½	5	4	12	7	2½	9	15¼
5x2	½	4½	5	4½	12	7	2½	9	18
6x2	½	4½	5	5	12	7	2½	9	21¼

For 1¼″ and 1½″ tapping, B – 4¾″, R′ – 2¼″. Other dimensions same as above.

DIMENSIONS FOR T BRANCHES

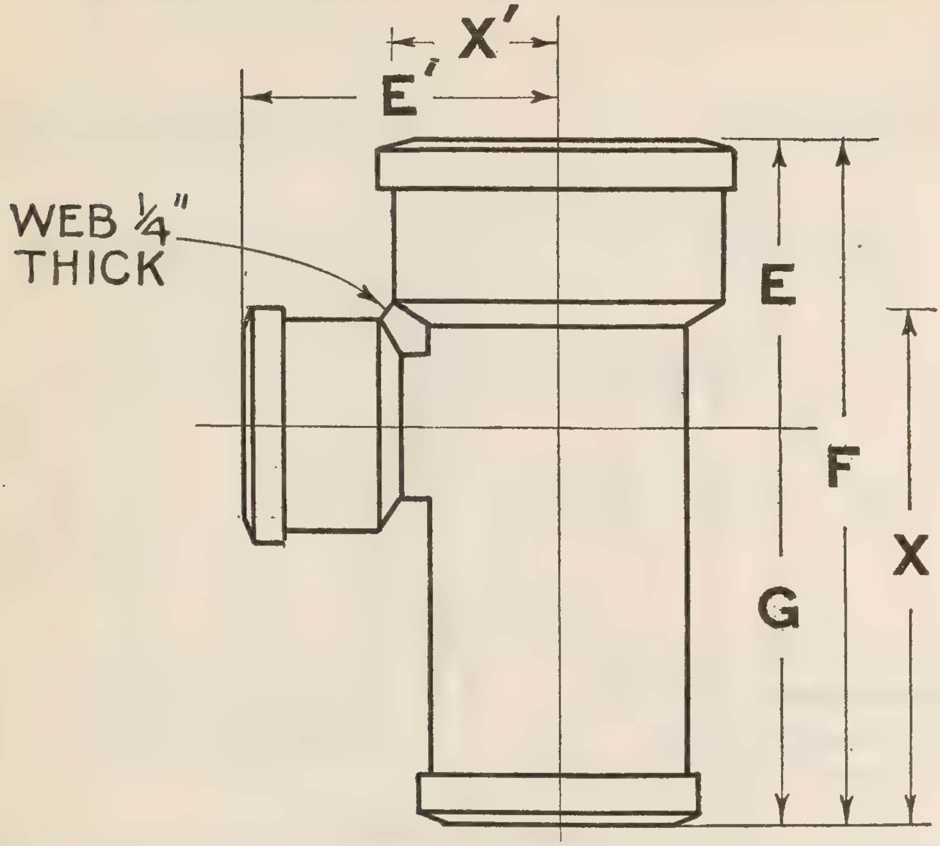


Fig. 6,881.—*T branch.*

"T" Branch

Size Inches	E	E′	F	G	X	X′	Weight Pounds
2	4½	4½	11½	7	9	2	10¼
3	5¼	5¼	12¾	7½	10	2½	15¼
4	6	6	14	8	11	3	21
5	6½	6½	15	8½	12	3½	26½
6	7	7	16	9	13	4	32½
3x2	4¾	5	11¾	7	9	2½	13¼
4x2	5	5½	12	7	9	3	16½
4x3	5½	5¾	13	7½	10	3	18¾
5x2	5	6	12	7	9	3½	19¼
5x3	5½	6¼	13	7½	10	3½	22
5x4	6	6½	14	8	11	3½	24½
6x2	5	6½	12	7	9	4	22½
6x3	5½	6¾	13	7½	10	4	25
6x4	6	7	14	8	11	4	27½
6x5	6½	7	15	8½	12	4	30

DIMENSIONS FOR SANITARY T BRANCHES

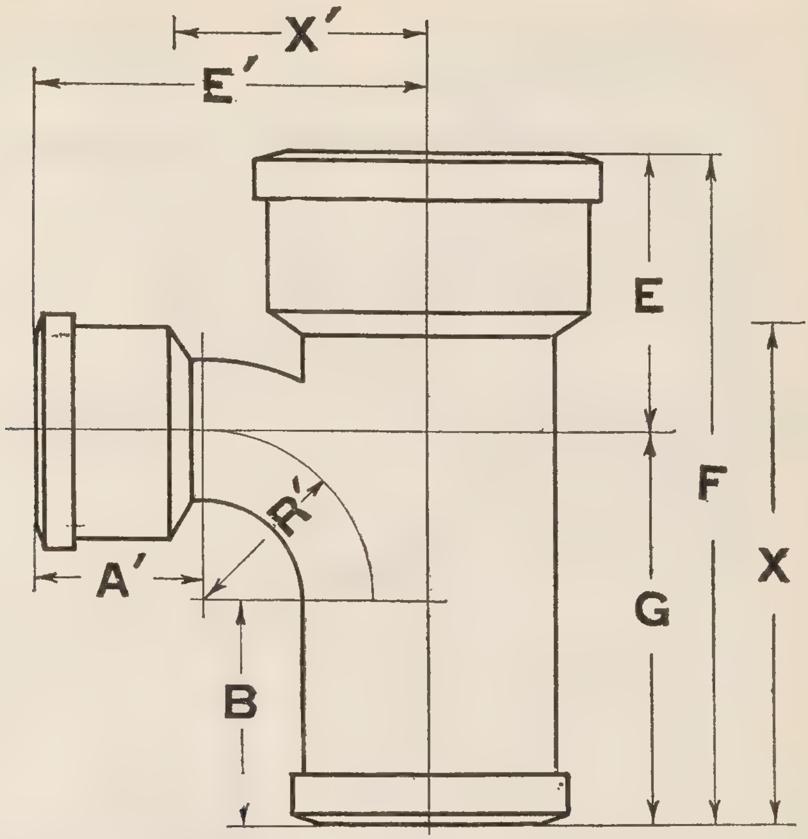
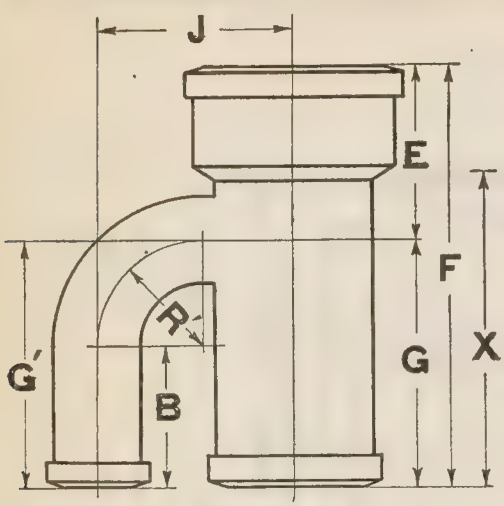


Fig. 6,882.—*Sanitary T branch.*

Sanitary "T" Branch

Size Inches	A′	B	E	E′	F	G	R′	X	X′	Weight Pounds
2	3	4	4½	6	11½	7	3	9	3½	11
3	3¼	4	5¼	6¾	12¾	7½	3½	10	4	16¼
4	3½	4	6	7½	14	8	4	11	4½	22½
5	3½	4	6½	8	15	8½	4½	12	5	28
6	3½	4	7	8½	16	9	5	13	5½	34½
3x2	3	4	4¾	6½	11¾	7	3	9	4	14
4x2	3	4	5	7	12	7	3	9	4½	17¼
4x3	3¼	4	5½	7¼	13	7½	3½	10	4½	19¾
5x2	3	4	5	7½	12	7	3	9	5	20
5x3	3¼	4	5½	7¾	13	7½	3½	10	5	23
5x4	3½	4	6	8	14	8	4	11	5	25½
6x2	3	4	5	8	12	7	3	9	5½	23
6x3	3¼	4	5½	8¼	13	7½	3½	10	5½	26
6x4	3½	4	6	8½	14	8	4	11	5½	29
6x5	3½	4	6½	9½	15	8½	4½	12	5½	31½

DIMENSIONS FOR VENT BRANCHES



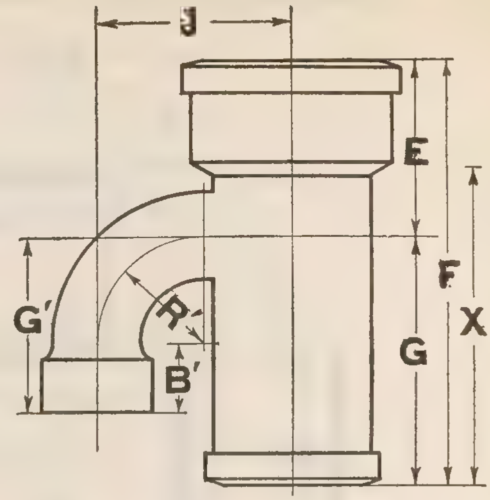


FIG. 6,883.—*Vent branch.*
FIG. 6,884.—*Tapped vent branch.*

Vent Branch

Size Inches	B	E	F	G	G′	J	R′	X	Weight Lbs.
2	4	4½	11½	7	7	4½	3	9	11½
3	4	5¼	12¾	7½	7½	5½	3½	10	17¾
4	4	6	14	8	8	6½	4	11	25
5	4	6½	15	8½	8½	7½	4½	12	32½
6	4	7	16	9	9	8½	5	13	41
3x2	4	4¾	11¾	7	7	5	3	9	14¾
4x2	4	5	12	7	7	5½	3	9	17¾
4x3	4	5½	13	7½	7½	6	3½	10	21½
5x2	4	5	12	7	7	6	3	9	21
5x3	4	5½	13	7½	7½	6½	3½	10	24½
5x4	4	6	14	8	8	7	4	11	28½
6x2	4	5	12	7	7	6½	3	9	23½
6x3	4	5½	13	7½	7½	7	3½	10	27½
6x4	4	6	14	8	8	7½	4	11	31½
6x5	4	6½	15	8½	8½	8	4½	12	36

Tapped Vent Branch

Size Inches	B′	E	F	G	G′	J	R′	X	Weight Lbs.
2x2	1⅝	5	11½	7	4⅝	4½	3	9	11¼
3x2	1⅝	5	11¾	7	4⅝	5	3	9	14¼
4x2	1⅝	5	12	7	4⅝	5½	3	9	17½
5x2	1⅝	5	12	7	4⅝	6	3	9	20¼
6x2	1⅝	5	12	7	4⅝	6½	3	9	23

Tapping boss on fittings may be tapped for 1¼ to 2 inch pipe threads inclusive.

DIMENSIONS FOR OFFSETS

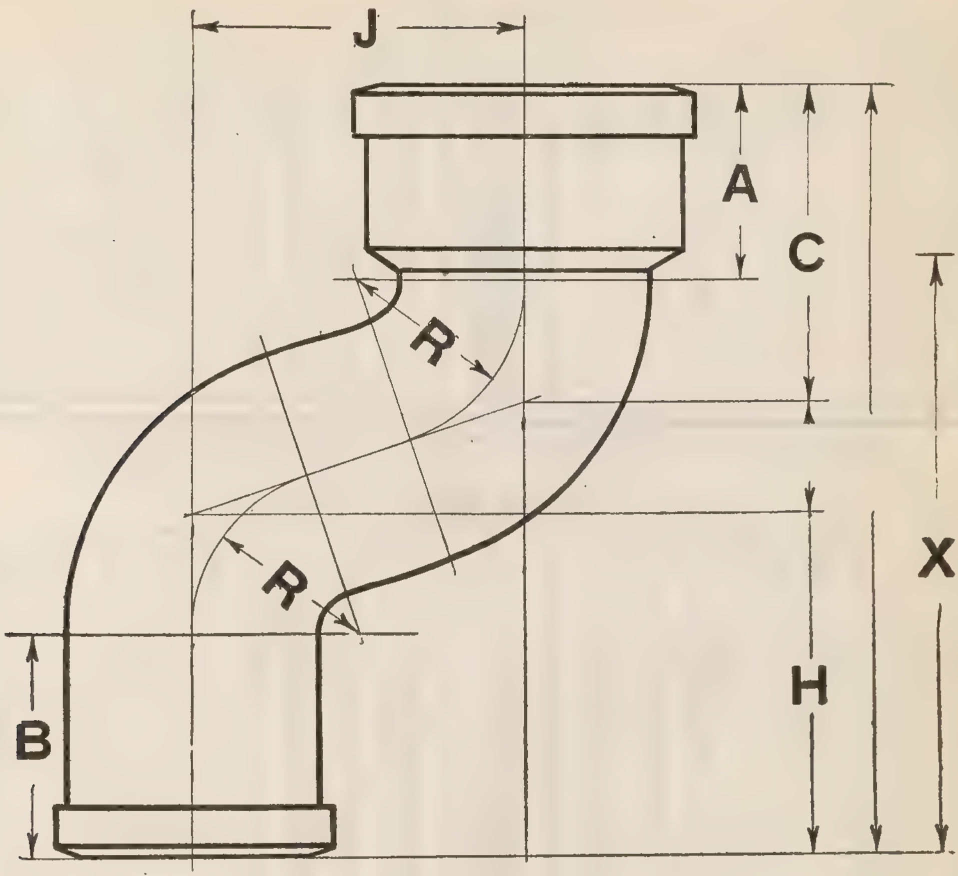


FIG. 6,885.—***Offsets, 2 to 6 inch.***

2 Inch Offset

Size Inches	A	B	C	D	F	H	J	R	X	Weight Pounds
2x2	3	4	3¾	4¾	10½	2	2	2	8	7
2x4	"	"	4½	5½	11	1	4	"	8½	8
2x 6	"	"	"	"	11½	1½	6	"	9	9
2x 8	"	"	"	"	12	2	8	"	9½	9¾
2x10	"	"	"	"	12½	2½	10	"	10	10¾
2x12	"	"	"	"	13	3	12	"	10½	11¾
2x14	"	"	"	"	13½	3½	14	"	11	12¾
2x16	"	"	"	"	14	4	16	"	11½	13¾
2x18	"	"	"	"	14½	4½	18	"	12	14½
2x20	"	"	"	"	15	5	20	"	12½	15½
2x22	"	"	"	"	15½	5½	22	"	13	16½
2x24	"	"	"	"	16	6	24	"	13½	17½

DIMENSIONS FOR OFFSETS

3 Inch Offset

3x 2	3¼	4	4¼	5	11¼	2	2	2½	8½	10¼
3x 4	"	4⅛	$5\frac{3}{16}$	$6\frac{1}{16}$	12¼	1	4	"	9½	12
3x 6	"	"	"	"	12¾	1½	6	"	10	13¼
3x 8	"	"	"	"	13¼	2	8	"	10½	14¾
3x10	"	"	"	"	13¾	2½	10	"	11	16
3x12	"	"	"	"	14¼	3	12	"	11½	17½
3x14	"	"	"	"	14¾	3½	14	"	12	18¾
3x16	"	"	"	"	15¼	4	16	"	12½	20½
3x18	"	"	"	"	15¾	4½	18	"	13	21½
3x20	"	"	"	"	16¼	5	20	"	13½	23
3x22	"	"	"	"	16¾	5½	22	"	14	24½
3x24	"	"	"	"	17¼	6	24	"	14½	26

4 Inch Offset

Size. Inches	A	B	C	D	F	H	J	R	X	Weight Pounds
4x 2	3½	4	4¾	5¼	12	2	2	3	9	13¾
4x 4	"	4	4¾	5¼	14	4	4	"	11	16¼
4x 6	"	4¼	5⅞	6⅝	14	1½	6	"	11	18
4x 8	"	"	"	"	14½	2	8	"	11½	19¾
4x10	"	"	"	"	15	2½	10	"	12	21½
4x12	"	"	"	"	15½	3	12	"	12½	23½
4x14	"	"	"	"	16	3½	14	"	13	25
4x16	"	"	"	"	16½	4	16	"	13½	27
4x18	"	"	"	"	17	4½	18	"	14	29
4x20	"	"	"	"	17½	5	20	"	14½	30½
4x22	"	"	"	"	18	5½	22	"	15	32½
4x24	"	"	"	"	18½	6	24	"	15½	34

5 Inch Offset

5x 2	3½	4⅛	$4\frac{15}{16}$	$5\frac{9}{16}$	12½	2	2	3½	9½	17¼
5x 4	"	4⅛	$4\frac{15}{16}$	$5\frac{9}{16}$	14½	4	4	"	11½	20½
5x 6	"	4½	6¼	7¼	15	1½	6	"	12	22½
5x 8	"	"	"	"	15½	2	8	"	12½	25
5x10	"	"	"	"	16	2½	10	"	13	27
5x12	"	"	"	"	16½	3	12	"	13½	29½
5x14	"	"	"	"	17	3½	14	"	14	31½
5x16	"	"	"	"	17½	4	16	"	14½	33½
5x18	"	"	"	"	18	4½	18	"	15	36
5x20	"	"	"	"	18½	5	20	"	15½	38
5x22	"	"	"	"	19	5½	22	"	16	40½
5x24	"	"	"	"	19½	6	24	"	16½	42½

DIMENSIONS FOR OFFSETS

6 Inch Offset

6x 2	3½	4⅛	5	5⅝	13	2⅜	2	4,	10	21
6x 4	"	4⅛	5 3/16	5 13/16	15	4	4	"	12	24½
6x 6	"	4¾	6⅝	7⅞	16	1½	6	"	13	28
6x 8	"	"	"	"	16½	2	8	"	13½	30½
6x10	"	"	"	"	17	2½	10	"	14	33
6x12	"	"	"	"	17½	3	12	"	14½	35½
6x14	"	"	"	"	18	3½	14	"	15	38½
6x16	"	"	"	"	18½	4	16	"	15½	41
6x18	"	"	"	"	19	4½	18	"	16	43½
6x20	"	"	"	"	19½	5	20	"	16½	46½
6x22	"	"	"	"	20	5½	22	"	17	49
6x24	"	"	"	"	20½	6	24	"	17½	51½

DIMENSIONS FOR BEND OFFSETS

(Accompanying illustration on next page)

2 Inch 1-8 Bend Offset

Size Inches	A	B	C	D	F	H	J	R	X	Weight Pounds
2x 2	3	4	3¾	4¾	10½	2	2	2	8	7
2x 4	"	"	"	"	12½	4	4	"	10	8¼
2x 6	"	"	"	"	14½	6	6	"	12	9½
2x 8	"	"	"	"	16½	8	8	"	14	10¾
2x10	"	"	"	"	18½	10	10	"	16	12
2x12	"	"	"	"	20½	12	12	"	18	13¼
2x14	"	"	"	"	22½	14	14	"	20	14¾
2x16	"	"	"	"	24½	16	16	"	22	16
2x18	"	"	"	"	26½	18	18	"	24	17¼
2x20	"	"	"	"	28½	20	20	"	26	18½
2x22	"	"	"	"	30½	22	22	"	28	19¾
2x24	"	"	"	"	32½	24	24	"	30	21

3 Inch 1-8 Bend Offset

3x 2	3¼	4	4¼	5	11¼	2	2	2½	8½	10¼
3x 4	"	"	"	"	13¼	4	4	"	10½	12
3x 6	"	"	"	"	15¼	6	6	"	12½	14
3x 8	"	"	"	"	17¼	8	8	"	14½	15¾
3x10	"	"	"	"	19¼	10	10	"	16½	17¾
3x12	"	"	"	"	21¼	12	12	"	18½	19½
3x14	"	"	"	"	23¼	14	14	"	20½	21½
3x16	"	"	"	"	25¼	16	16	"	22½	23½
3x18	"	"	"	"	27¼	18	18	"	24½	25½
3x20	"	"	"	"	29¼	20	20	"	26½	27
3x22	"	"	"	"	31¼	22	22	"	28½	29
3x24	"	"	"	"	33¼	24	24	"	30½	31

DIMENSIONS FOR BEND OFFSETS

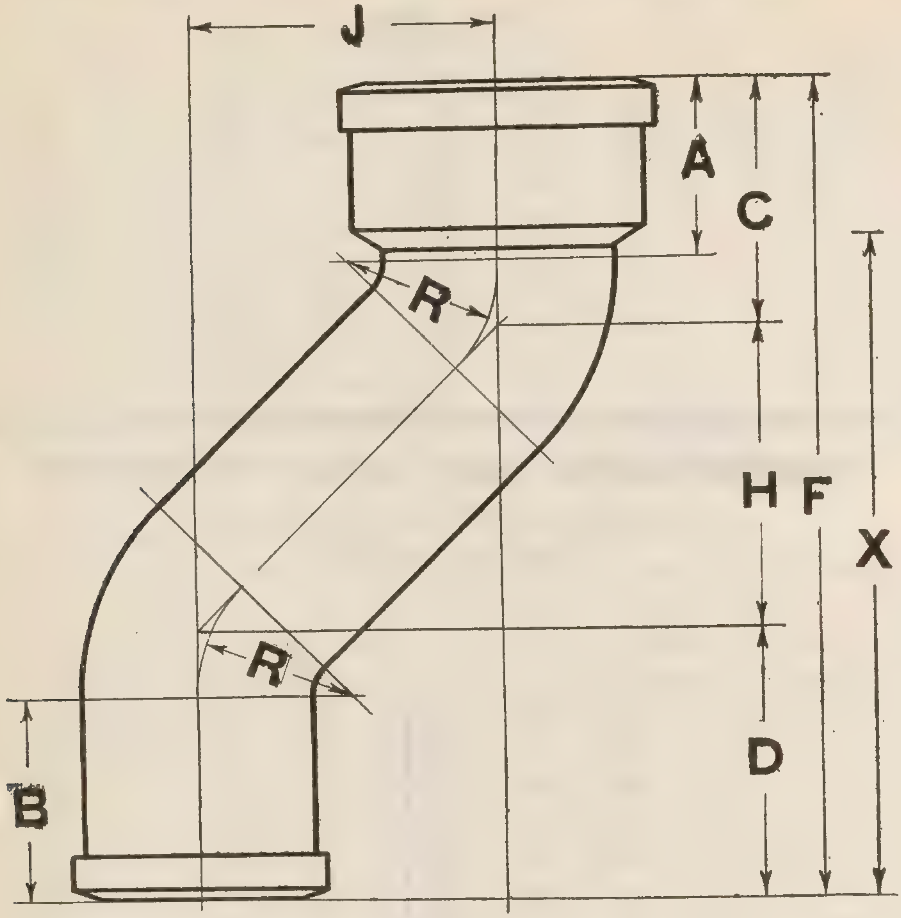


FIG. 6,886.—*Bend offsets, 2 to 6 inch.*

4 Inch 1-8 Bend Offset

Size Inches	A	B	C	D	F	H	J	R	X	Weight Pounds
4x 2	3½	4	4¾	5¼	12	2	2	3	9	13¾
4x 4	"	"	"	"	14	4	4	"	11	16¼
4x 6	"	"	"	"	16	6	6	"	13	18¾
4x 8	"	"	"	"	18	8	8	"	15	21
4x10	"	"	"	"	20	10	10	"	17	23½
4x12	"	"	"	"	22	12	12	"	19	26
4x14	"	"	"	"	24	14	14	"	21	28½
4x16	"	"	"	"	26	16	16	"	23	31
4x18	"	"	"	"	28	18	18	"	25	33½
4x20	"	"	"	"	30	20	20	"	27	36
4x22	"	"	"	"	32	22	22	"	29	38½
4x24	"	"	"	"	34	24	24	"	31	41

DIMENSIONS FOR BEND OFFSETS

5 Inch 1-8 Bend Offset

5x 2	3½	4⅛	4 15/16	5 9/16	12½	2	2	3½	9½	17¼
5x 4	"	"	"	"	14½	4	4	"	11½	20½
5x 6	"	"	"	"	16½	6	6	"	13½	23½
5x 8	"	"	"	"	18½	8	8	"	15½	26½
5x10	"	"	"	"	20½	10	10	"	17½	29½
5x12	"	"	"	"	22½	12	12	"	19½	32½
5x14	"	"	"	"	24½	14	14	"	21½	35½
5x16	"	"	"	"	26½	16	16	"	23½	38½
5x18	"	"	"	"	28½	18	18	"	25½	41½
5x20	"	"	"	"	30½	20	20	"	27½	44½
5x22	"	"	"	"	32½	22	22	"	29½	47½
5x24	"	"	"	"	34½	24	24	"	31½	50½

6 Inch 1-8 Bend Offset

6x 2	3½	4⅛	5	5⅝	13	2⅜	2	4	10	21
6x 4	"	"	5 3/16	5 13/16	15	4	4	"	12	24½
6x 6	"	"	"	"	17	6	6	"	14	28
6x 8	"	"	"	"	19	8	8	"	16	31½
6x10	"	"	"	"	21	10	10	"	18	35½
6x12	"	"	"	"	23	12	12	"	20	39
6x14	"	"	"	"	25	14	14	"	22	42½
6x16	"	"	"	"	27	16	16	"	24	46
6x18	"	"	"	"	29	18	18	"	26	49½
6x20	"	"	"	"	31	20	20	"	28	53½
6x22	"	"	"	"	33	22	22	"	30	57
6x24	"	"	"	"	35	24	24	"	32	60½

NOTE.—***Suggestions for ordering fittings.*** Long ¼ bends are measured from the inside of hub nearest spigot to end of spigot. Other long bends are measured from end of spigot to nearest point on inside base of hub. Long tees, Y's, etc. are measured from the base of the hub on main to the end of the spigot.

NOTE.—***To determine the right or left hand inlet or outlet in bends,*** branches and offsets, place them with the hub facing toward you, and with spigot lower than hub. On traps, place in regular position with the hub end nearest you.

NOTE.—***Always state weight of pipe and fittings desired,*** whether standard, medium or extra heavy; also whether plain or tarred. If for Canadian use, whether plain, tarred or oiled.

DIMENSIONS FOR HUBS OR BELLS

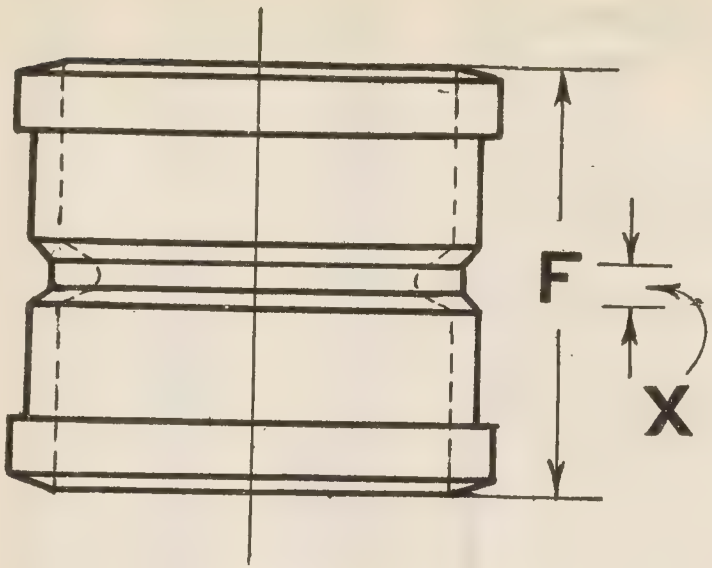


FIG. 6.887—*Short double hub or single hub.*

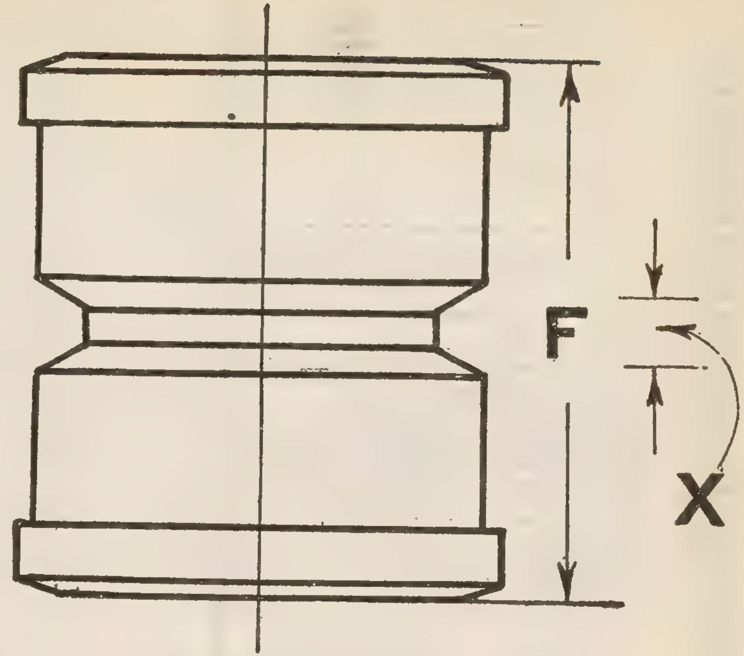


FIG. 6,888.—*Double hub.*

Short Double Hub or Single Hub

Size Inches	F	X	Weight Pounds
2	4½	½	4¾
3	5	½	6¾
4	5½	½	9¼
5	5½	½	10¾
6	5½	½	12½

Double Hub

Size Inches	F	X	Weight Pounds
2	6	1	5¾
3	6½	1	8¼
4	7	1	10¾
5	7	1	12¾
6	7	1	14¾

DIMENSIONS FOR SLEEVES AND REDUCERS

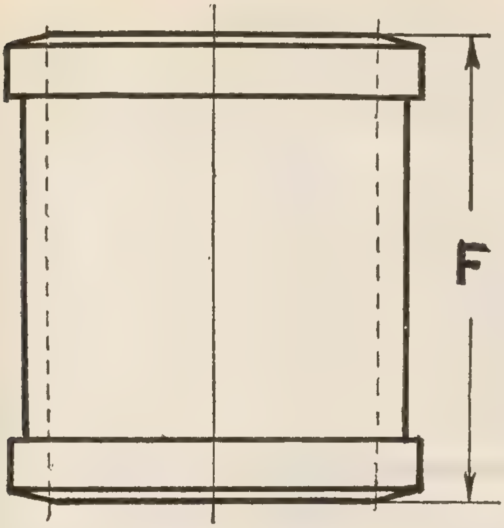


FIG. 6,889.—*Straight sleeve.*

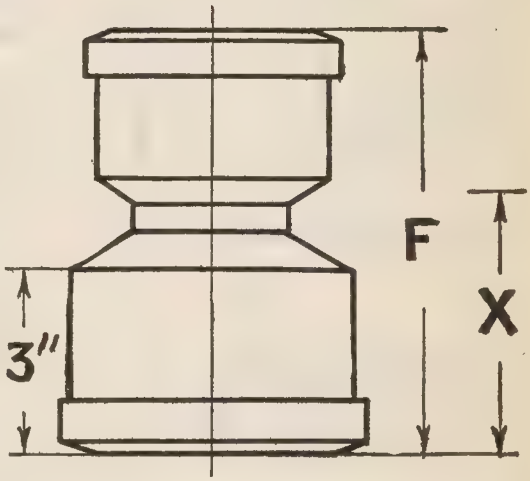


FIG. 6,890.—*Reducer.*

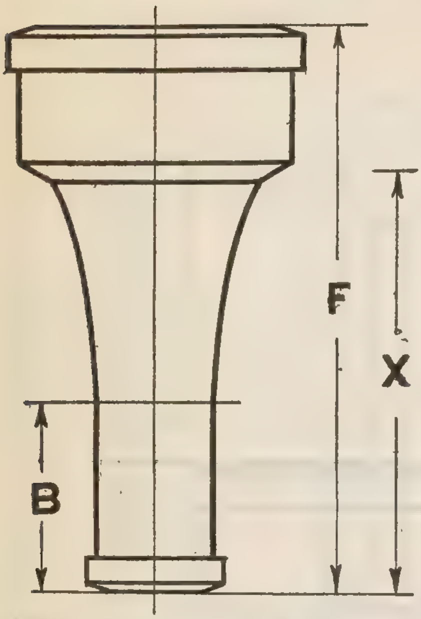
Straight Sleeve

Size Inches	F	Weight Pounds
2	6	6¼
3	6½	8½
4	7	11¼
5	7	13¼
6	7	15¼

Reducer

Size Inches	F	X	Weight Pounds
3x2	7½	5	6¼
4x2	7½	5	7
4x3	7¾	5	8½
5x2	7½	5	8
5x3	7¾	5	9¼
5x4	8	5	10¾
6x2	7½	5	8¾
6x3	7¾	5	10¼
6x4	8	5	11¾
6x5	8	5	12¾

DIMENSIONS FOR INCREASERS



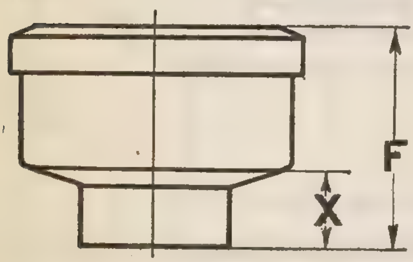


FIG. 6,891.—*Increaser.*

FIG. 6,892.—*Short tapped increaser.*

Increaser

Size Inches	B	F	X	Weight Pounds
2x3	4	11¾	9	8¾
2x4	4	12	9	10½
2x5	4	12	9	12
2x6	4	12	9	13½
3x4	4	12	9	12
3x5	4	12	9	13½
3x6	4	12	9	14¾
4x5	4	12	9	14¾
4x6	4	12	9	16¼
5x6	4	12	9	17½

Short Tapped Increaser

Size Inches	F	X	Weight Pounds
2	3⅞	1⅝	4
3	4¼	"	5¼
4	4½	"	7
5	"	"	8¼
6	"	"	9½

Tapped Increaser

Size Inches	B	F	X	Weight Pounds
2x2	4	11½	9	7½
2x3	4	11¾	9	9¼
2x4	4	12	9	11
2x5	4	12	9	12½
2x6	4	12	9	14

Tapping boss on fittings may be tapped for 1¼ to 2 inch pipe threads inclusive.

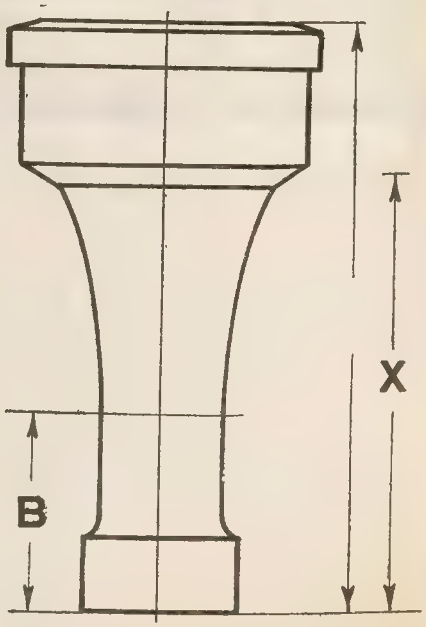


FIG. 6,893.—*Tapped increaser.*

DIMENSIONS FOR TRAPS

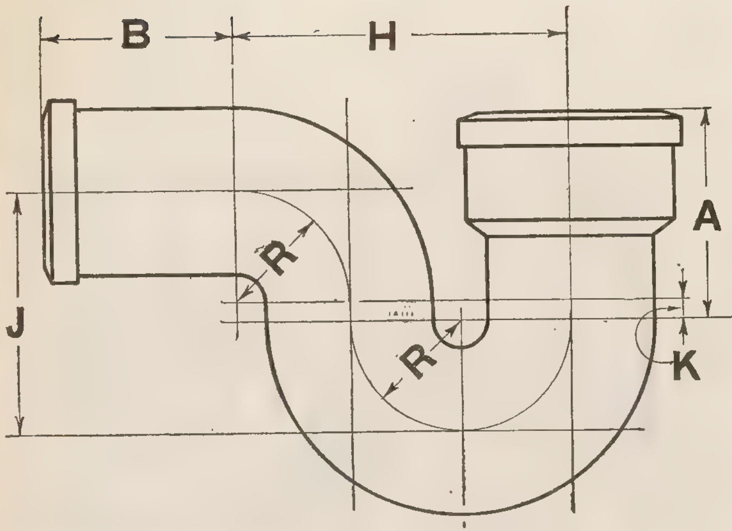


FIG. 6,894.—½ *S or P trap.*

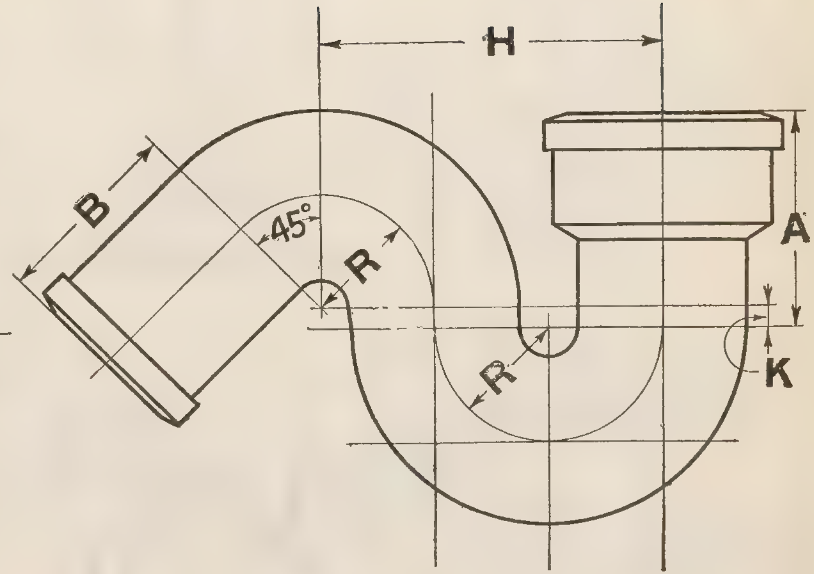


FIG. 6,895.—¾ *S trap.*

1-2 "S" or "P" Trap

Size In.	A	B	H	J	K	R	Wght Lbs.
2	3½	5	6	4½	½	2	10½
3	4½	5	7½	5½	"	2½	17¼
4	5½	5	9	6½	"	3	25½
5	6½	5	10½	7½	"	3½	34½
6	7½	5	12	8½	"	4	45

3-4 "S" Trap

Size In.	A	B	H	K	R	Wght Lbs.
2	3½	5	6	½	2	11¼
3	4½	5	7½	"	2½	18½
4	5½	5	9	"	3	27½
5	6½	5	10½	"	3½	37½
6	7½	5	12	"	4	49

DIMENSIONS OF TRAPS

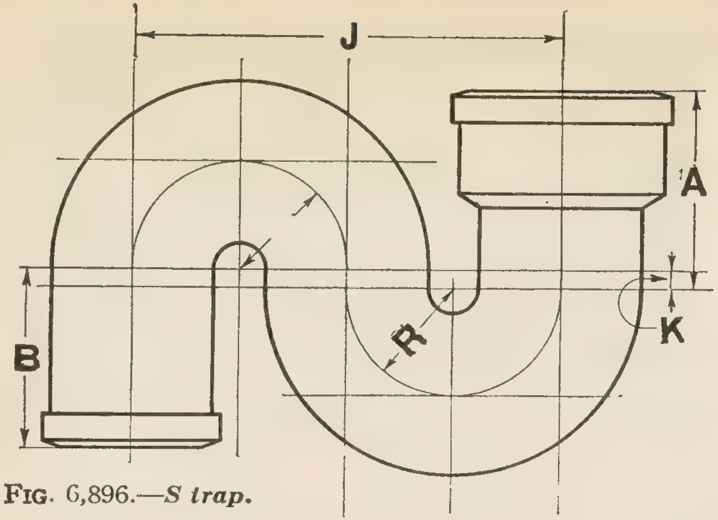


FIG. 6,896.—*S trap.*

"S" Trap

Size In.	A	B	J	K	R	Wght. Lbs.
2	3½	5	8	½	2	12
3	4½	5	10	"	2½	20
4	5½	5	12	"	3	30
5	6½	5	14	"	3½	40½
6	7½	5	16	"	4	53½

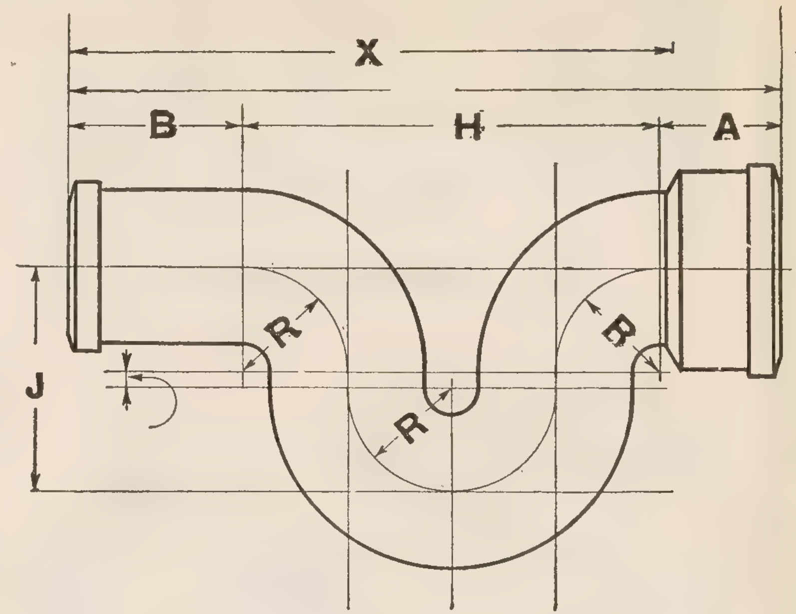
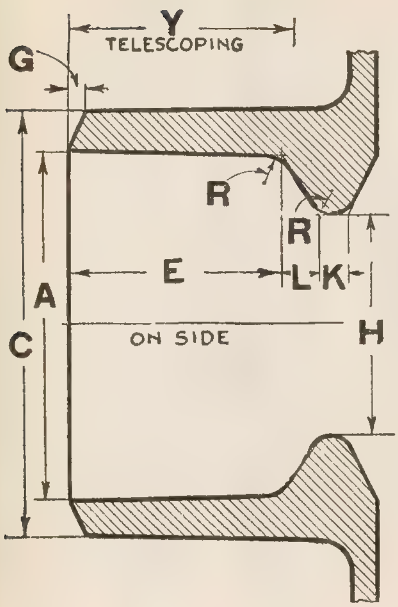


FIG. 6,897.—*Running trap.*

Running Trap

Size Inches	A	B	F	H	J	K	R	X	Weight Lbs.
2	3	5	16	8	4½	½	2	13½	11¾
3	3¼	5	18¼	10	5½	"	2½	15½	19
4	3½	5	20½	12	6½	"	3	17½	27½
5	3½	5	22½	14	7½	"	3½	19½	37
6	3½	5	24½	16	8½	"	4	21½	48

DIMENSIONS OF HUBS AND SPIGOTS



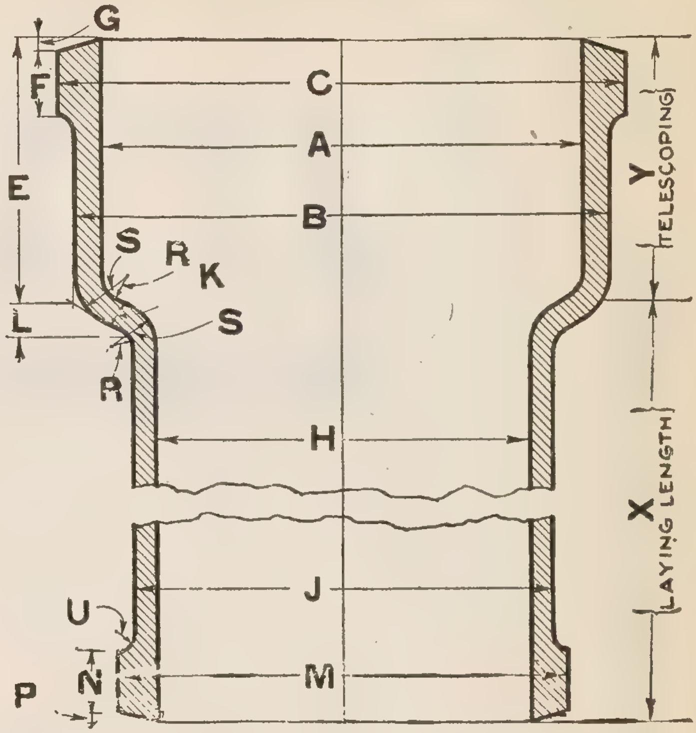


FIG. 6,898.—*Side inlet hub.*
FIG. 6,899.—*Bell or hub and spigot.*

Side Inlet Hub

Size In.	A	C	E	G	H	K	L	R	Y
2	3¼	4	2	⅛	2	5/16	⅜	¼	2¼
3	4¼	5	2¼	"	3	"	"	"	2½
4	5¼	6	2½	"	4	"	"	"	2¾
5	6¼	7	"	"	5	"	"	"	"
6	7¼	8	"	"	6	"	"	"	"

Soil Pipe Hubs and Spigots

Dimensions of Fitting Hubs and Spigots same as above

Size In.	A	B	C	E	F	G	H	Min. Wall	J	K	L	⅜	N	P	R	S	T	U	X	Y	Wgt. per Lgth.
2	3 3/16	3 13/16	4 3/16	2⅜	⅝	⅛	2	¼	2½	9/32	⅜	2⅞	9/16	⅛	¼	17/32	3/16	3/16	60	2½	27½
3	4 3/16	4 13/16	5 3/16	2⅝	11/16	"	3	"	3½	"	"	3⅞	⅝	"	"	"	"	"	"	2¾	47½
	5 3/16	5 13/16	6 3/16	2⅞	¾	"	4	"	4½	"	"	4⅞	11/16	"	"	"	"	"	"	3	65
	6 3/16	6 13/16	7 3/16	"	"	"	5	"	5½	"	"	5⅞	"	"	"	"	"	"	"	"	85
6	7 3/16	7 13/16	8 3/16	"	"	"	6	"	6½	"	"	6⅞	"	"	"	"	"	"	"	"	100

DIMENSIONS OF TAPPING BOSSES

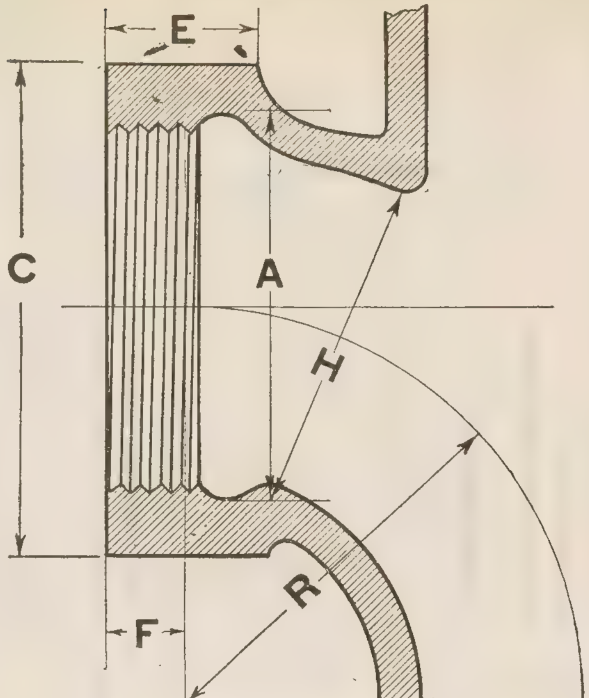


FIG. 6,900.—*Tapping boss for tapped sanitary Ts, etc.*

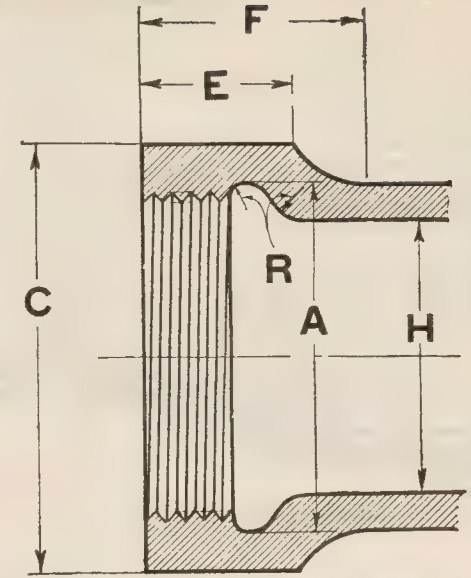


FIG. 6,901.—*Tapping boss for other fittings.*

1¼″ to 2″ Tapping Boss on Tapped Sanitary Tees and Tapped Sanitary Crosses

Size In.	A	C	E	F	H	R	Lgth. of Thrd.
1¼	2	2⅝	1	½	1½	2¼	⅝
1½	"	"	"	"	"	"	"
2	2½	3⅛	"	"	2	2½	"

1¼″ to 2″ Tapping Boss on Tapped Fittings other than Tees, Sanitary Tees, Crosses and Sanitary Crosses

Size In.	A	C	E	F	H	R	Lgth. of Thrd.
1¼	2½	3⅛	1⅛	1⅝	2	3/16	⅝
1½	"	"	"	"	"	"	"
2	"	"	"	"	"	"	"

DIMENSIONS OF TAPPING BOSSES AND PLUGS

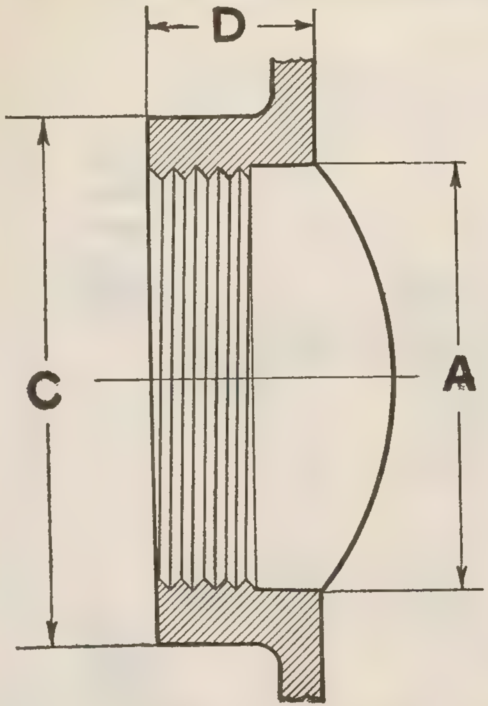


FIG. 6,902.—*Tapping boss for tapped T's and tapped crosses.*

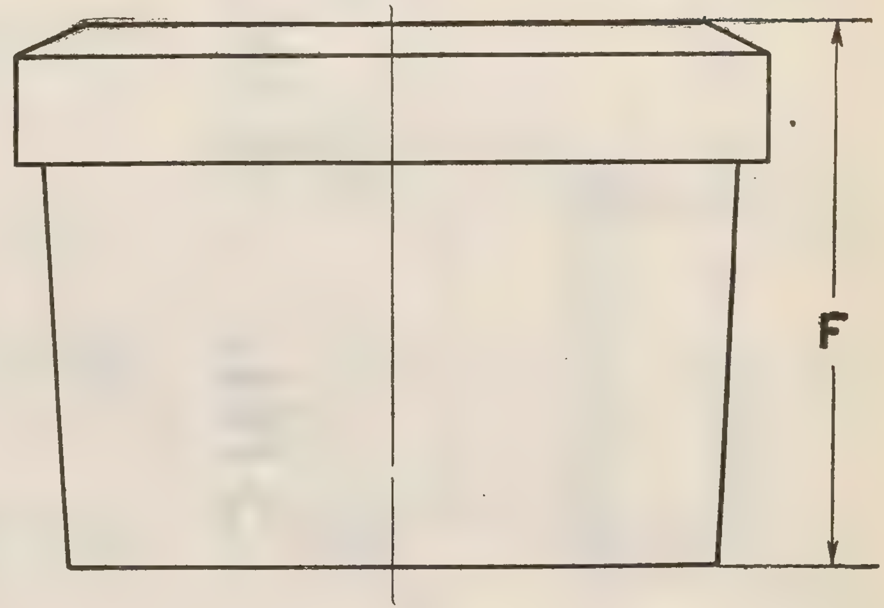


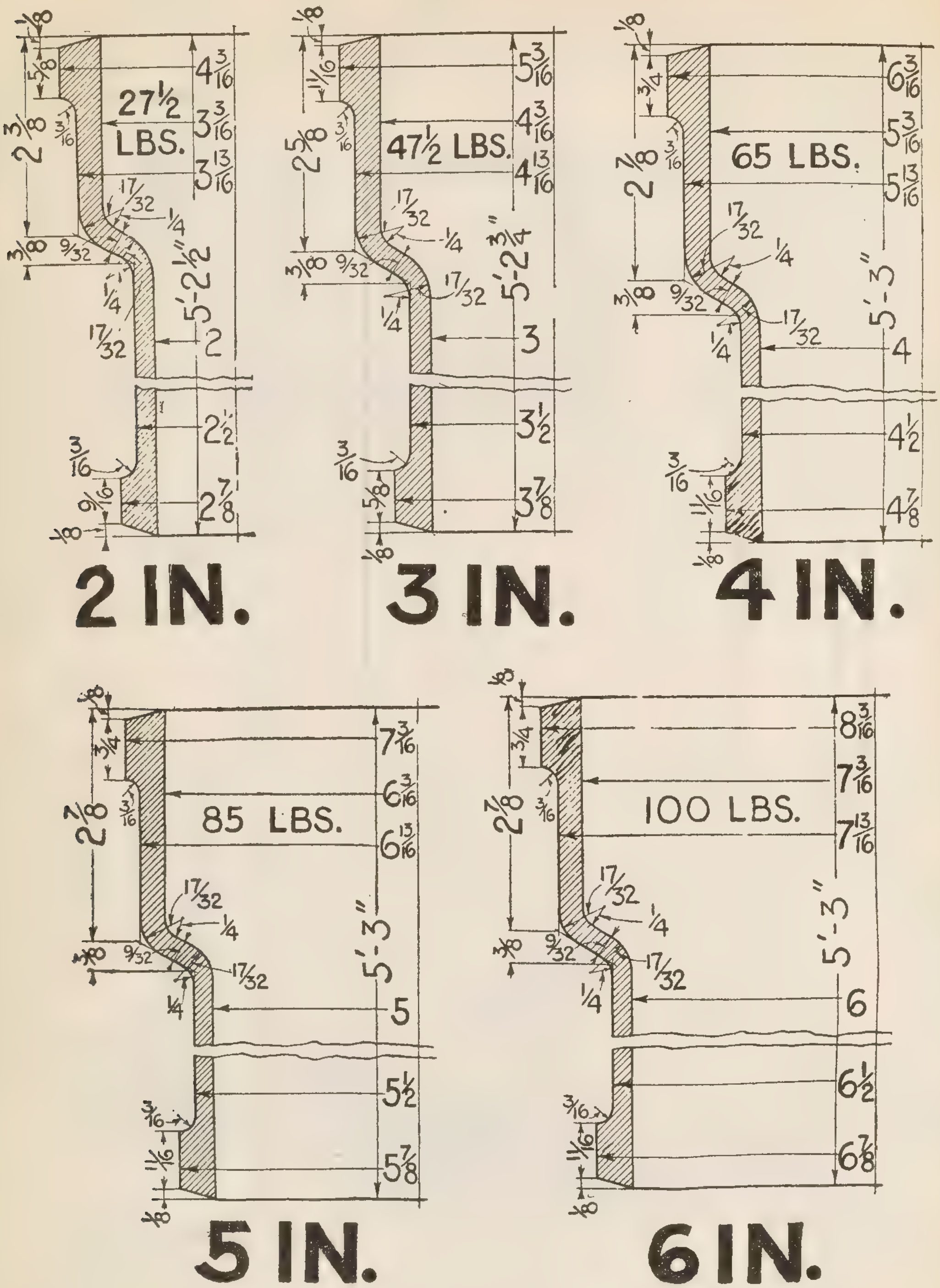
FIG. 6,903.—*Plug.*

1¼" to 2" Tapping Boss on Tapped Tees and Tapped Crosses

Size Inches	A	C	D	Length of Thread
1¼	2	2⅝	1	⅝
1½	2	"	"	"
2	2½	3⅛	"	"

Plug

Size Inches	F	Weight Pounds
2	3	1½
3	3¼	2¾
4	3½	4
5	3½	5
6	3½	6½



FIGS. 6,904 to 6,908.—Pipe and fitting dimensions of hubs and spigots. ***Length of telescoping:*** 2½ ins. for 2 in. pipe; 2¾ ins. for 3 in. pipe; 3 ins. for 4, 5 and 6 in. pipe.

CHAPTER 117

Roughing In

By definition, the term "roughing in" means *the installation of the piping ready for the attachment of the fixtures.**

Broadly speaking, roughing in work, comprises not only the operation of assembling the piping, but in the absence of working drawings, the planning of the system as to pipe sizes and selection of fittings, that will give efficient operation with least expense for material and labor; also especially in old buildings the cutting away of woodwork necessary for the installation of the piping. In this respect the skilled plumber should be at least a second rate carpenter—he should know what to cut and what not to cut so that the piping may be installed without unnecessarily weakening the building.*

In order to fully present the work of roughing in and yet not tire the student with an unnecessary repetition of similar

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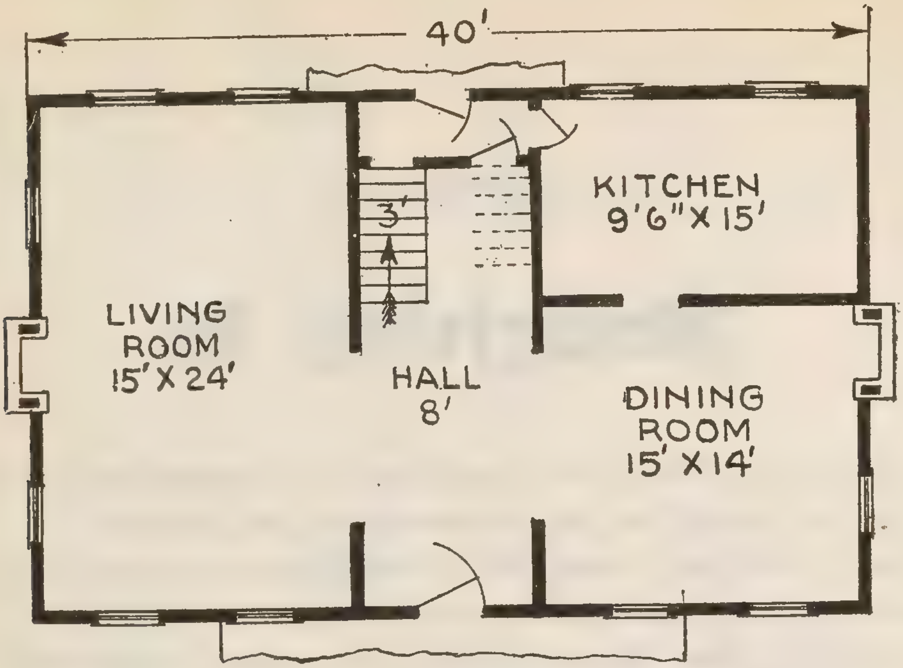
*NOTE.—***Roughing in,** broadly speaking, comprises the piping of both the water supply and the drainage systems, but on account of space required to present the subject properly, only drainage work is considered in this chapter, the installation of the water supply system being presented in the chapter on Pipe Fitting.

*NOTE.—When the plumber is called upon to install a plumbing system in an old building, a knowledge of building construction is essential in order to so plan the location of the fixtures and piping that the roughing in work may be properly done, to secure proper drainage, and least cutting away of the woodwork. When the installation is made, without regard to the building construction, damaged floor beams, water pockets, and other faults are the result. To avoid these errors, the author suggests that the student obtain a proper knowledge of the construction of wooden buildings by a study of the author's Carpentry and Builders Guide No. 3. This knowledge is essential also in making a proper estimate on a plumbing installation in an old building.



PLAN OF FIRST FLOOR
SCALE 1/8 IN.=1 FT

PLAN OF SECOND FLOOR
SCALE 1/8 IN.=1 FT

FIG. 6,909.—Small wooden house; ***plan 1st floor,*** illustrating roughing in work in old building
FIG. 6,910.—Small wooden house; ***plan 2nd floor,*** illustrating roughing in work in old building.

operations, an example is here given illustrating the roughing in for an old building of small size, thus presenting roughing in, in all its phases, that is, embracing the problems of

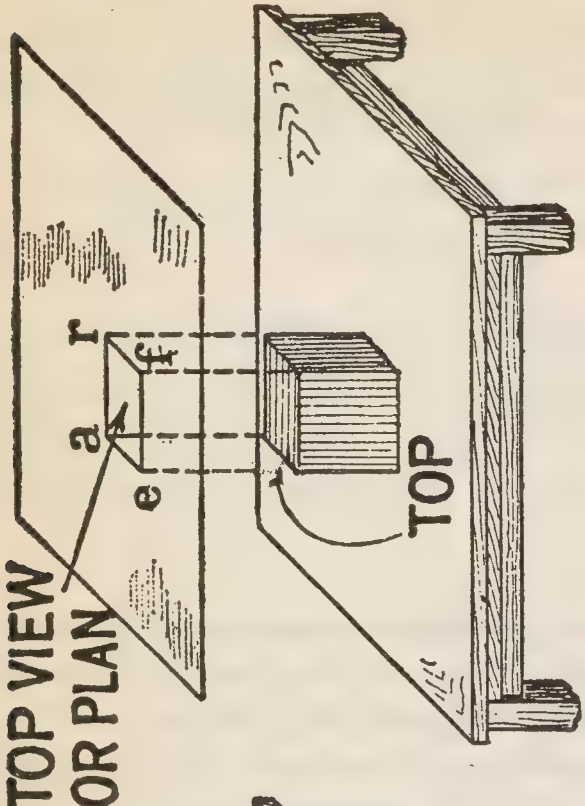
1. Location of fixtures.
2. Selection of pipe and fittings.
3. Cutting away of woodwork.
4. Assembling.

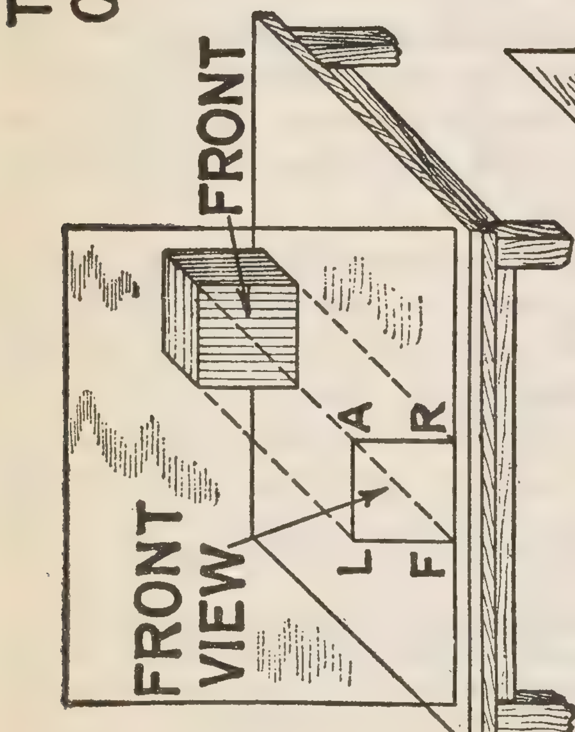
Example.—It is desired to install in the small building shown in figs. 6,909 and 6,910, a simple plumbing system providing adequate water supply and drainage for a kitchen, and a bath room on second floor.

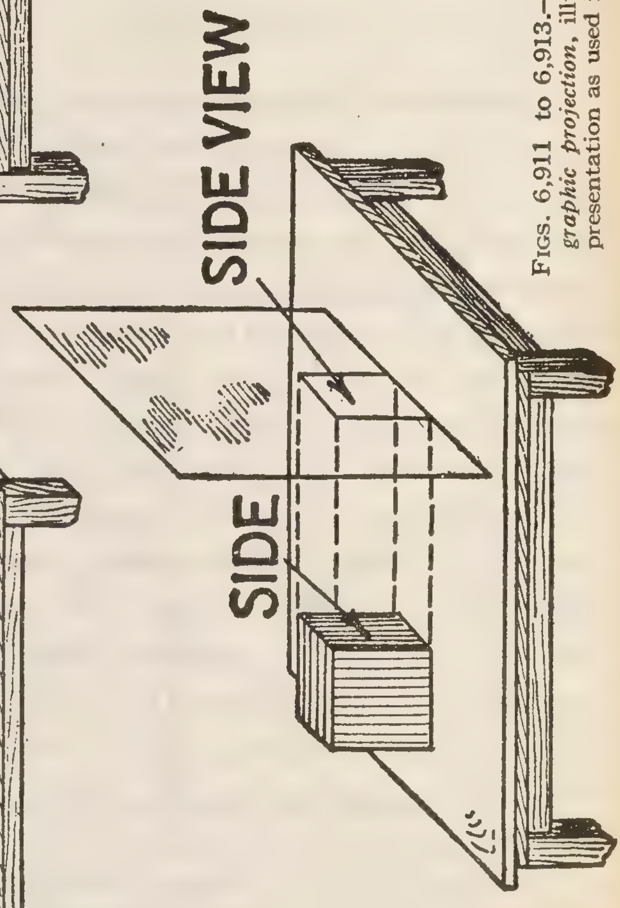
Location.—The kitchen being fixed, the first problem is the selection of a room on the second floor for the bath room. In fig. 6,910, room A, is the most desirable with respect to size because it is the smallest and most easily heated. With respect to expense of installation room C, is the most desirable because, being directly over the kitchen the plumbing can be installed with less material and labor. However, using room C, necessitates using the small room A, for a bed room, which may, or may not offset the saving in cost.

Considering room C, for the bath room, it is larger than is necessary, hence, by running a partition as indicated by dotted lines in fig. 6,910, a closet for linen, etc. is obtained and the size of bath room reduced making it easier to heat in cold weather. An additional door will be necessary at M, for entrance to bath room, and if desired, the latter may be made directly accessible to the adjoining bed room by providing another door at some point S.

The location of the fixtures depends upon convenience, and details of the building construction. Due regard should be paid to the latter point so that proper drainage of pipes under floors may be secured without too much cutting and consequent weakening of the floor beams.







FIGS. 6,911 to 6,913.—Various ***"views"*** of an object in *orthographic projection*, illustrating the principles of this mode of representation as used in giving "roughing in measurements."

The fixtures to be served are:

1. For the kitchen.
   a. Sink.
   b. Laundry tubs.
   c. Hot water tank.

2. For the bath room.
   a. Bath tub.
   b. Wash basin.
   c. Closet.

The *approximate* location of the fixtures will depend (as already mentioned) upon convenience and the building construction, that is locating them so that they will be conveniently used, and easily reached by the piping.

The *exact* location of the fixtures will depend in addition upon the "roughing in" measurements of the fixtures. Accordingly at this stage, the fixtures to be used should be selected from the great multiplicity of type available, in order to know the roughing in measurements so that the pipes may be placed in exactly the right position to connect with the fixtures.

To properly present these roughing in measurements, the fixture is represented not by a photographic view or perspective drawing but by *orthographic projection,* in which only one side of the object is shown in a single view, as illustrated in figs. 6,911 to 6,913. Here the object to be represented in orthographic projection consists of a cube resting on a table as shown.

To illustrate how the views or projections are obtained, assume a clear pane of glass to be placed between the observer and the object at right angles to the line of vision when the observer looks directly at the object. Now when the observer looks directly at the front of an object from a considerable distance, he will see only one side, in this case only the front side of the cube (that is, the side next to the observer). The rays of light falling upon the cube are reflected into the eyes of the observer, and in this manner he sees the cube. The pane of glass evidently, is placed so that the rays of light from the object will pass through the glass in straight lines to the eyes of the observer. The front side of the cube by its outline, may be traced upon the glass, and in this manner a figure drawn on it (as here taken, a square)

which is the view of the object as seen from the front which in this case is called the *front elevation*.

One view, however, is not sufficient to show the real form of a solid figure. In a single view two dimensions only can be shown, length and height; hence the thickness of an object will have to be shown by still another view of it, as the top view or *plan*.

Now, place the pane in a horizontal position above the cube which is resting on the table, as in fig. 6,912, and looking at it from above, directly over the top face of the cube, trace its outline upon the pane; as a result, a square figure is drawn upon the glass, which corresponds to the appearance of the cube, as seen from above. This square on the glass is the top view of the cube, or its *plan*.

Fig. 6,913 shows the manner in which a side view of the cube may be traced. The glass is placed on the side of the cube, which rests on the table as before, and the outline of the cube on the glass in this position, is called its *side elevation*.

Usually three views are required to fully represent a fixture and show all the roughing in dimensions.*

Roughing in Measurements—In selecting the fixtures, manufacturers catalogues are consulted. These catalogues contain not only photographic views of the different fixtures but orthographic drawings showing the roughing in measurements. In regard to the latter, the measurements may be given direct for a particular size of fixture, or where the fixture is made in a number of sizes the roughing in measurements are represented in the drawing by *letters* which refer to the same letters in a table of measurements which give values for the letters corresponding to the various sizes.

Proceeding to select the fixtures, suppose, for the wash basin or lavatory, a style listed in the "Standard" catalogue as Marco is selected.

Fig. 6,914, shows this lavatory as it appears from the photograph in the

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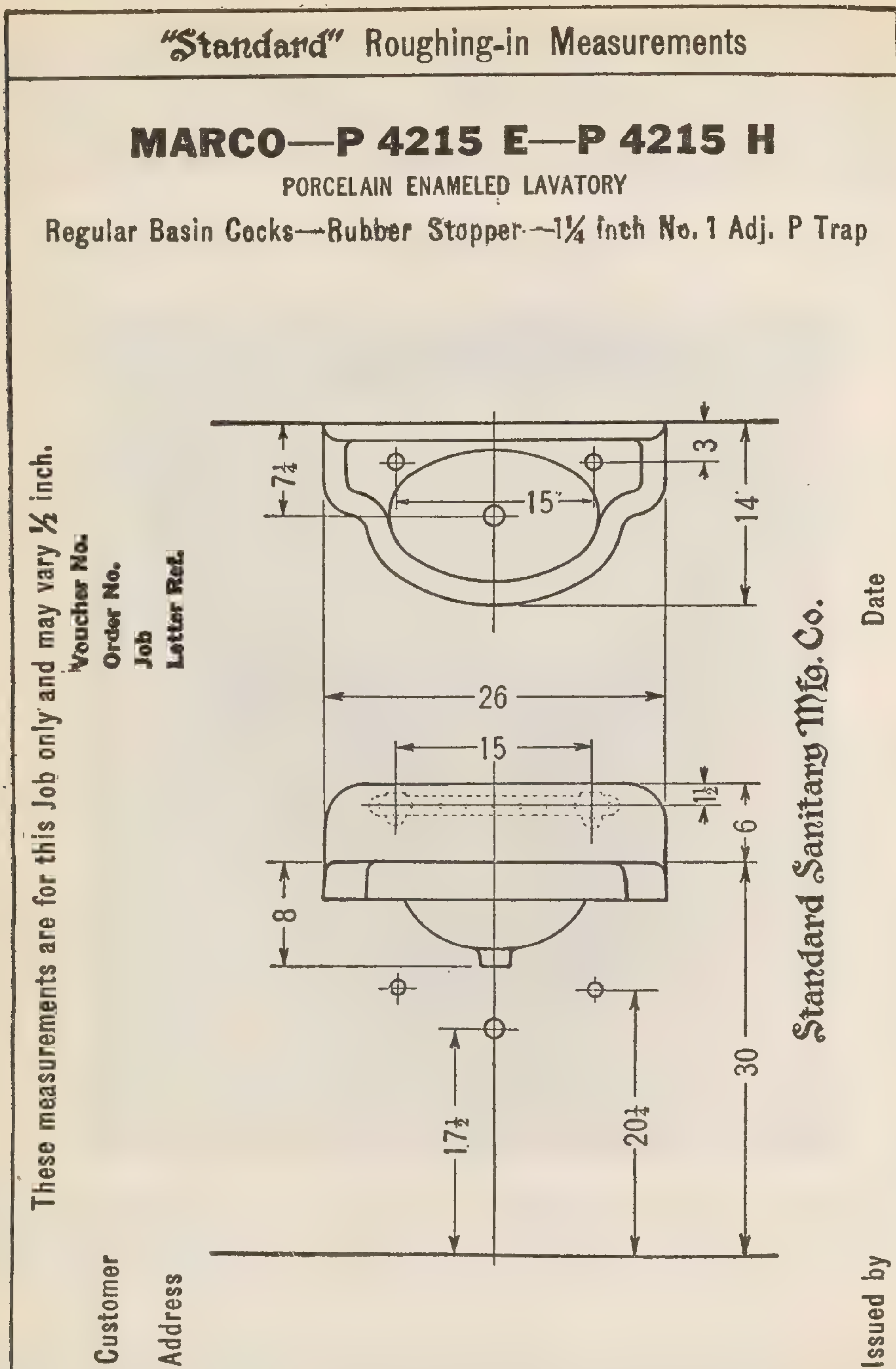
*NOTE.—***This explanation** of *orthographic projection* is an extract from the author's Carpenter's and Builders' Guide No. 2, which presents the subject at considerable length. The student is advised to study the entire section on drawing as given in Guide No. 2.

catalogue. This simply shows what the fixture looks like, and does not give the plumber any information from which he can install the piping. Compare this with the orthographic drawings of the same fixture as shown in figs. 6,915 and 6,916. Here all the measurements are given necessary to properly cut and connect up the piping. Two views are here required to give these measurements.

Fig. 6,915, is a *plan* or view looking down on the top of the fixture and

FIG. 6,914.—Standard ***Marco*** pattern lavatory with center outlet, oval bowl, supported on concealed wall hanger; fitted with nickel plated waste plug, rubber stopper, chain and chain stay, nickel plated Medio compression faucets with china index handles, nickel plated $\frac{3}{8}$ inch plain wall supply pipes and nickel plated $1\frac{1}{4}$ inch No. 1 adjustable "P" trap.

fig. 6,916, an *elevation* from the front side. The horizontal measurements or distances from the wall are given, and in fig. 6,916 the vertical measurements or distances from the floor.



Figs. 6,915 and 6,916.—Roughing in measurements for standard *Marco* pattern lavatory.

The foregoing illustrates the *method of giving the measurements direct.*

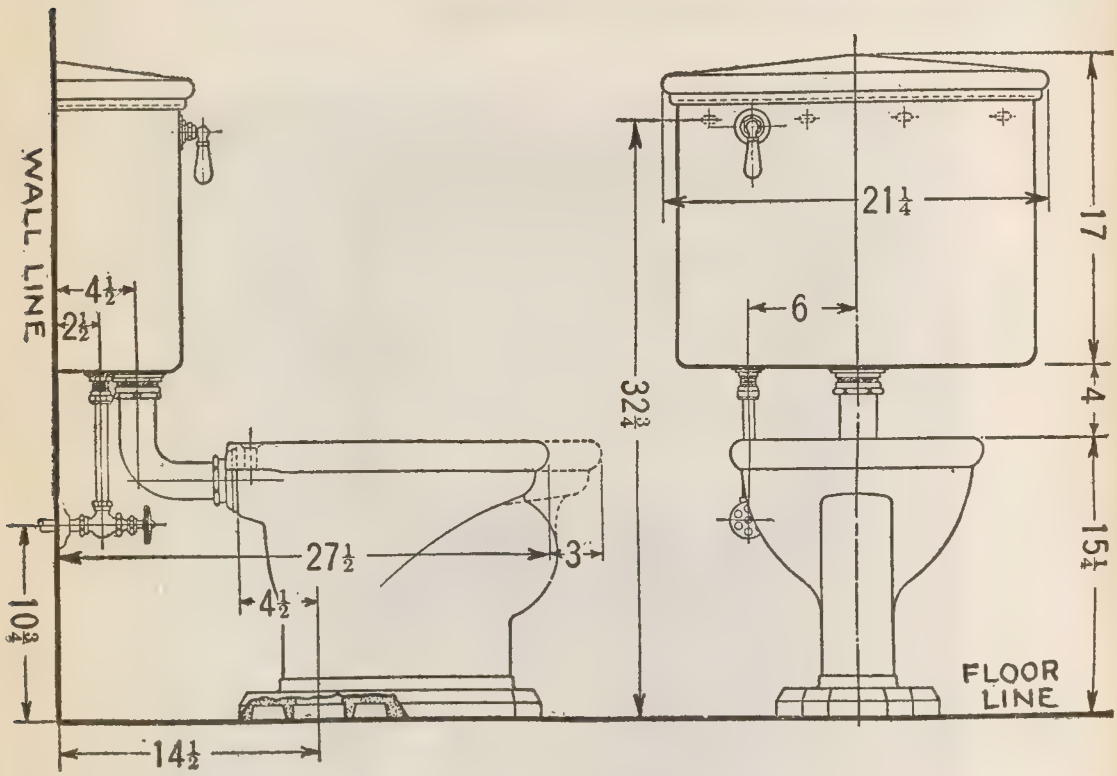
Similarly fig. 6,917 shows appearance of the type closet selected, and figs. 6,918 and 6,919 the roughing in dimensions of same.

Figs. 6,920 and 6,921 illustrate *the method of representing roughing in measurements by letters* so that several sizes of fixtures may be given with one set of drawings.

FIG. 6,917.—Standard Ejecto closet with square base; velrite china straight front low down tank; Universal No. 1 double acting top lever with china handle; nickel plated $\frac{3}{8}$ wall supply pipe, angle controlling stop with wheel handle; nickel plated flush connection; birch (mahogany finish) seat and cover; No. 8 cast brass special floor flange with bolts and vertical china bolt caps.

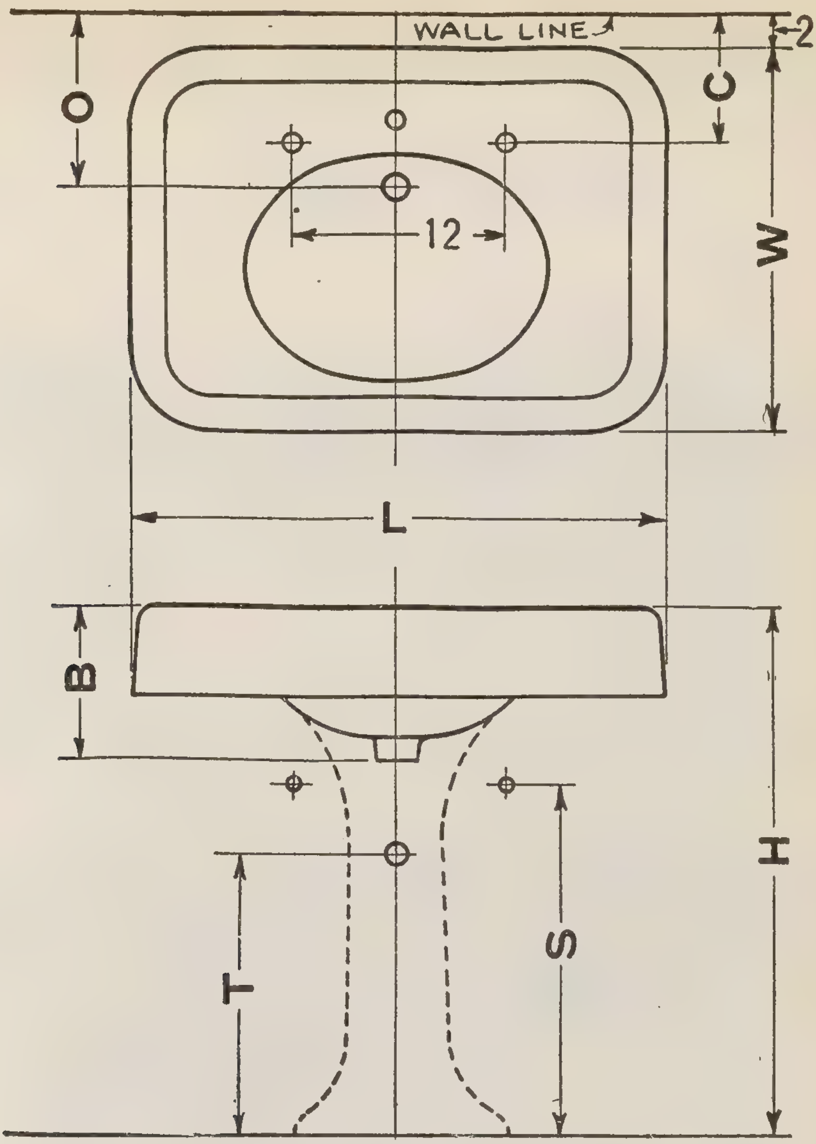
Here the letters W,L,O,C,H,B,T,S, in the drawings refer to values for same in the table. Thus the height H, from flow to top of basin, is for the 20×24 size 30¼ in., and for the 22×30 size, 31 ins.

In some cases, roughing in measurements are given partly direct and partly by letters as for fixtures in which only some of the measurements change for the different sizes such as bath tubs.



Figs. 6,918 and 6,919.—Roughing in dimensions for Standard *Ejecto* closet.

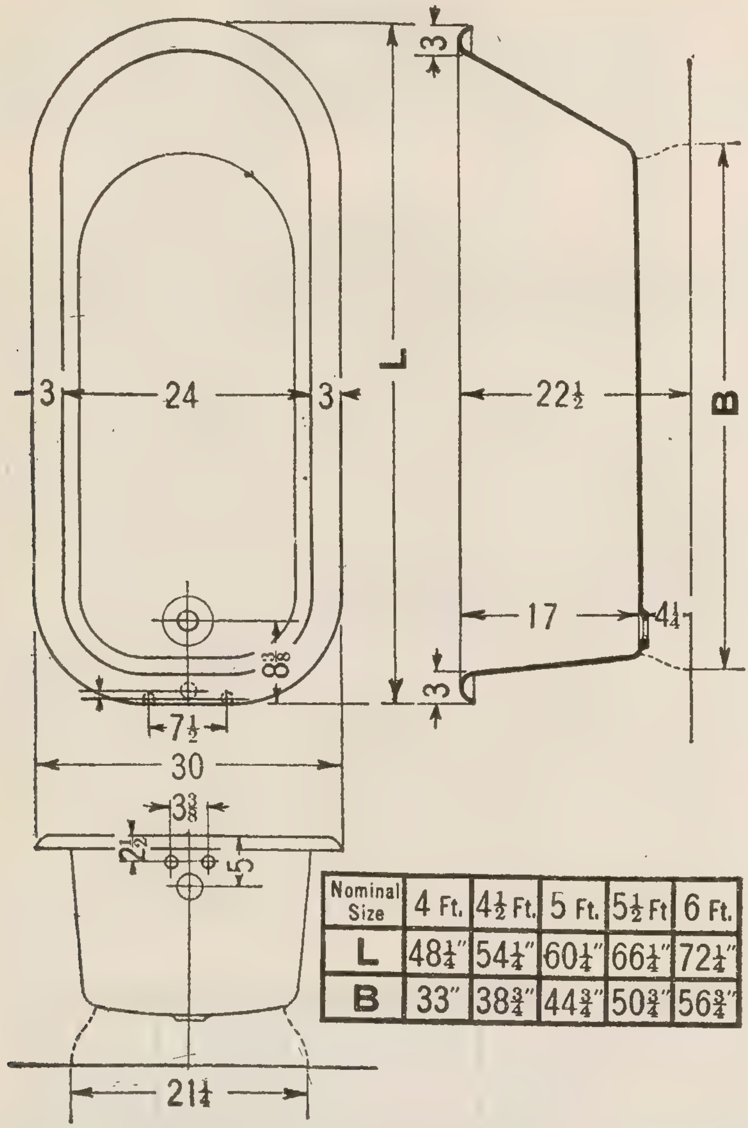
This is illustrated in the selection of the bath tub where roughing in measurements are shown in figs. 6,922 to 6,924. Here, as seen, all the measurements remain the same for the different sizes except L and B, or the length and base. Selecting the 5 ft. size tube for installation the plumber looks in the table under 5 ft. and reads 60¼ ins. for L, and 44¾ ins. for B, these values together with the measurements given direct on the drawings is all the information needed to properly locate the tub and make the pipe connections.



Nominal Size	W	L	O	C	H	B	T	S
20x24	20″	24½″	9½″	6½″	30¼″	8½″	15″	20½″
22x27	22″	27″	9¾″	7″	30¾″	8¾″	15″	21″
22x30	22½″	30½″	10½″	7¾″	31″	8¾″	15″	21¼″

FIGS. 6,920 and 6,921.—Roughing in measurements for Standard ***Laton*** pattern enameled lavatory illustrating the representation of roughing in measurement by letters, so that with the aid of a table these measurements for several sizes may be given without separate drawings for each size.

There remains to be selected the three fixtures for the kitchen consisting of sink, laundry tub and hot water tank or so called "boiler."*



Nominal Size	4 Ft.	4½ Ft.	5 Ft.	5½ Ft	6 Ft.
L	48¼"	54¼"	60¼"	66¼"	72¼"
B	33"	38¾"	44¾"	50¾"	56¾"

FIGS. 6,922 and6,924.—Roughing in measurements for Standard Essex pattern bath tub; selected for installation and to illustrate the representation of roughing in measurements partly direct and partly by letters.

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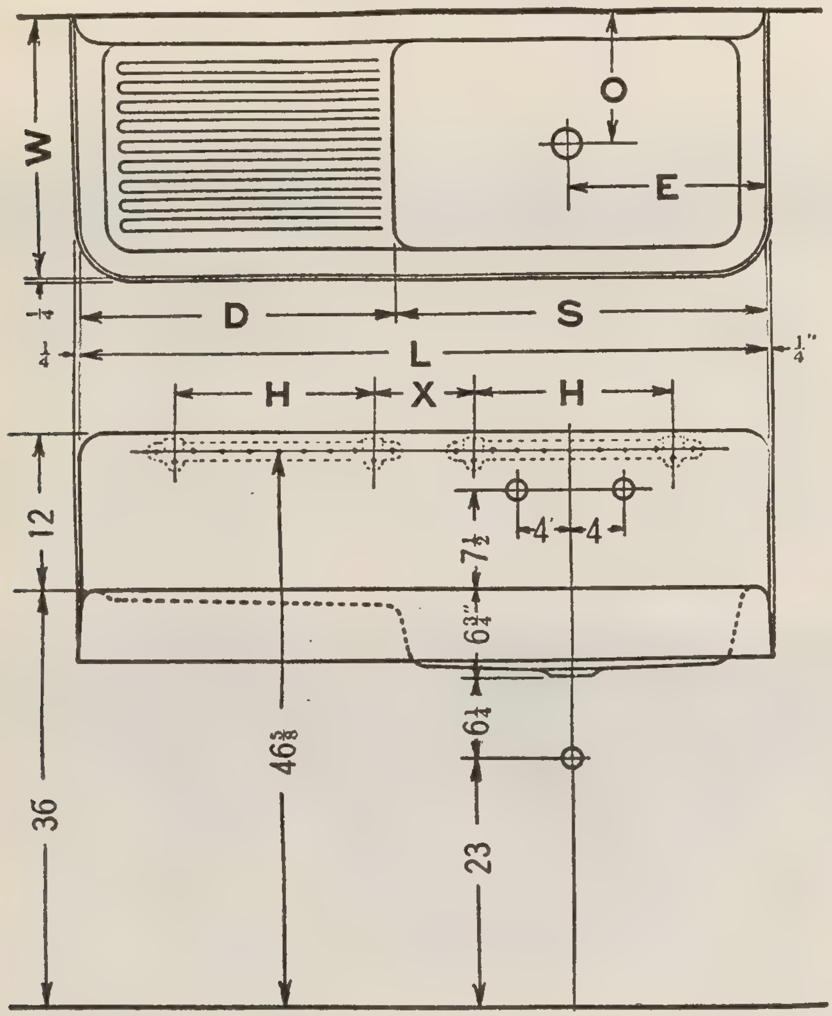
*NOTE.—The enlightened plumber will not make the common mistake of calling a hot water tank a "boiler" as its function is simply to store hot water which is heated in some external devise as a water back, or coil heater. Accordingly the term boiler is erroneously and very illy advisedly applied to a hot water storage tank.

Figs. 6,925 to 6,930 show roughing in measurements for these fixtures as selected, except hot water tank.

Before the work of installation is begun, not only the pipe and fittings, but the fixtures should be ordered to avoid delay after finishing the roughing in work.

FIG. 6,925.—Standard porcelain enameled one piece apron sink supported on concealed wall hangers; fitted with combination swinging spout faucet with removable china soap dish, duplex strainer and 1½ inch No. 1 adjustable "P" trap.

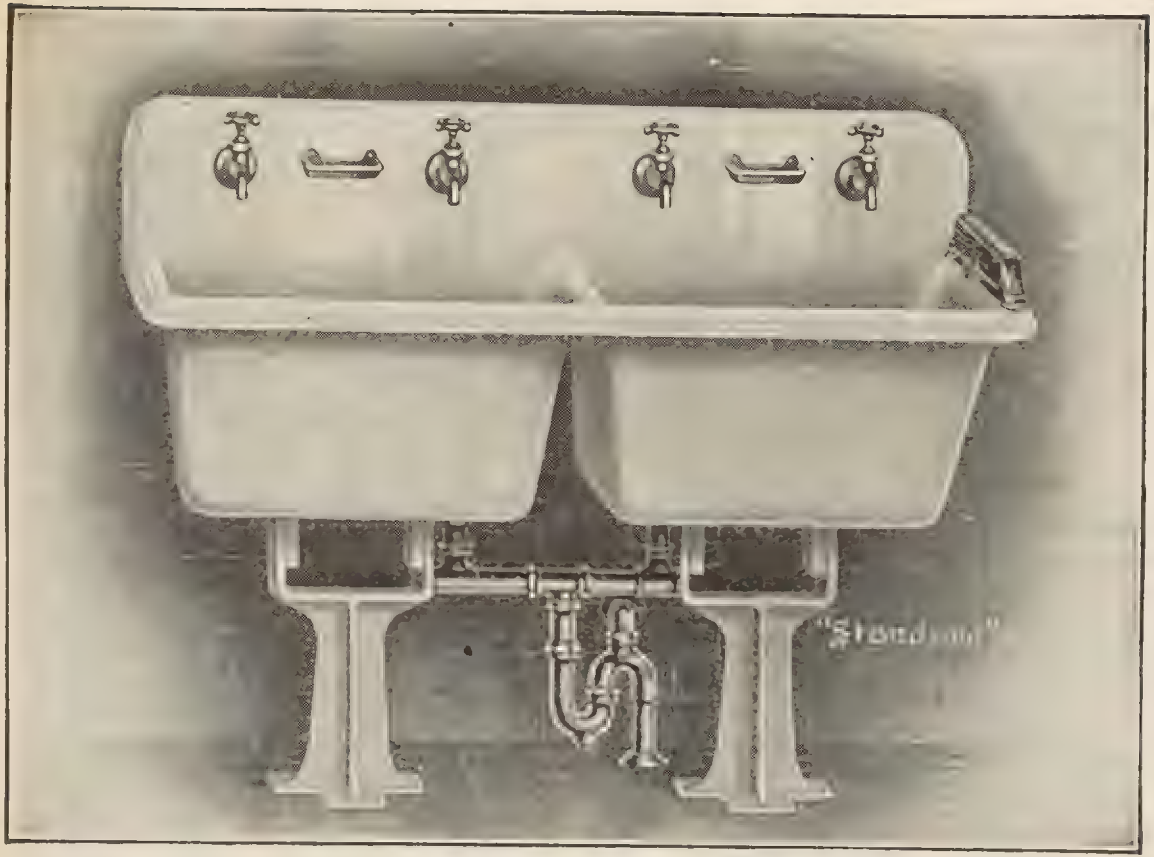
The most commonly used material for the drainage system is cast iron soil pipe and fittings. The pipe ordinarily comes in two grades: standard and extra heavy. The standard is too light and the extra heavy, too heavy. Regularly a medium grade,



Nominal Size	W	L	S	D	E	O	H	X
20x24	20"	42"	22"	20"	12"	10"	10½"	7½"
20x30	20"	52"	28"	24"	15"	10"	15"	7½"
22x36	22"	60"	34"	26"	18"	11"	15"	10"

FIGS. 6,926 and 6,927.—Roughing in measurements for Standard porcelain enameled one piece apron sink.

in the absence of same the extra heavy grade should be specified on first class work.*

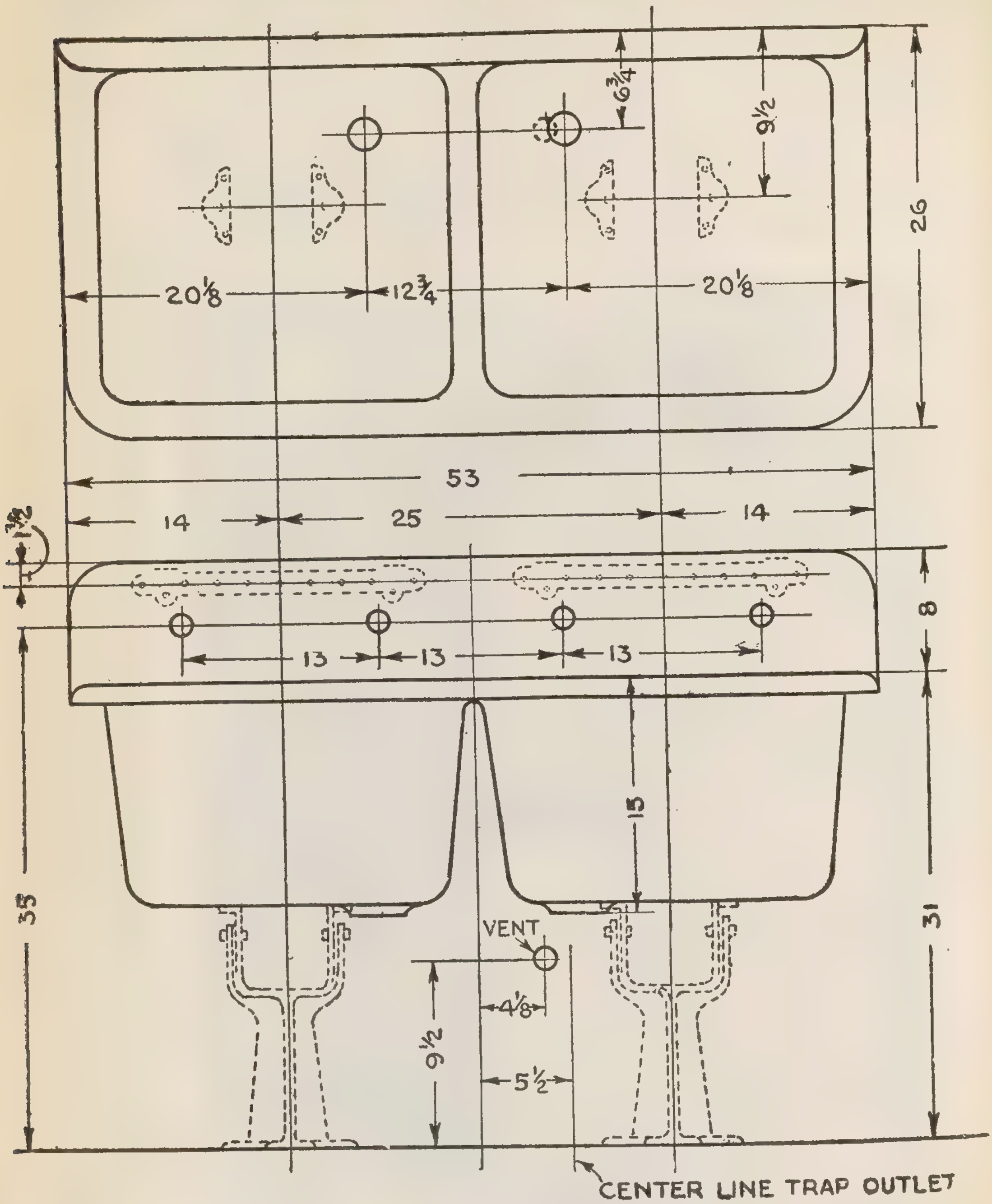


NOTE.—***To select a sink*** without one or more integral drain boards; and then have separate wood drain boards made, fitted and finished, means the expenditure of about the same amount of money as the cost of a sink complete with enameled drain boards, without a corresponding result.

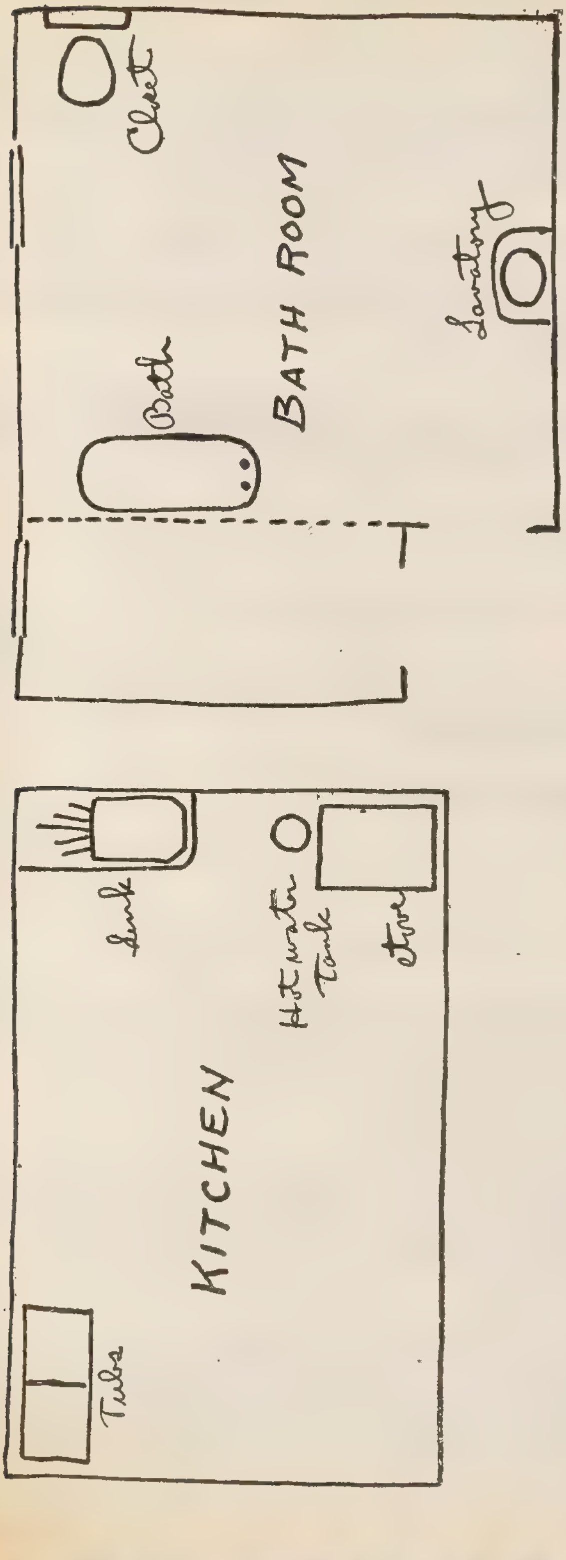
*NOTE.—The standard or light weight pipe has been condemned for many years by sanitary engineering experts and by progressive plumbers as an entirely unsuitable material for the purpose.—*W. P. Gerhard.*

FIG. 6,928.—Standard porcelain enameled roll rim two-section laundry tray and back all in one piece, on painted adjustable sanitary pedestals, and hard wood wringer holder on right hand end. Fitted with ½ inch nickel-plated compression, adjustable flange, stream regulating bibbs with four-ball china index handles, nickel-plated soap dishes, waste plugs and rubber stoppers and 1½ inch continuous waste with 1½ inch vented "S" trap.

Locating the Fixtures.—Preliminary free hand sketches



Figs. 6,929 and 6,930.—Roughing in measurements for porcelain enameled roll rim two section laundry tray, with 1½ in. continuous waste, 1½ in. vented S trap. The adjustable pedestal permits rim of tray to be set from 31 to 34 ins. from floor. The above roughing is for 31 ins. height.



FIGS. 6,931 and 6,932.—Free hand sketches showing location of fixtures as suggested by owner.

quickly made by the plumber to indicate the owners' preference as to location of the fixtures are executed as in figs. 6,931 and 6,932, with no indication of details or sizes. Usually such sketches show a nondescript arrangement of fixtures without regard to difficulties that might be encountered in piping up such arrangement. The plumber will then examine the construction of the building or inspect plans of same if these be available to see what mechanical difficulties will be encountered in installing the piping; he will note the spacing and direction in which the floor beams run and other details. This examination will show construction, say, as in figs. 6,933 and 6,934. With this information the plumber will take the free hand sketches showing owners' arrangement and

represent the beams in dotted lines as in figs. 6,935 and 6,936.

With the stack located as shown, the kitchen fixtures can be piped without cutting any floor beams, which is the condition most desired and accordingly the location of fixtures in kitchen is most satisfactory not only for convenience but also because it does not weaken the building.

Of course with respect to labor, saving the beams, will in some cases require more time in taking up the floor or cutting same depending upon the kind of floor.

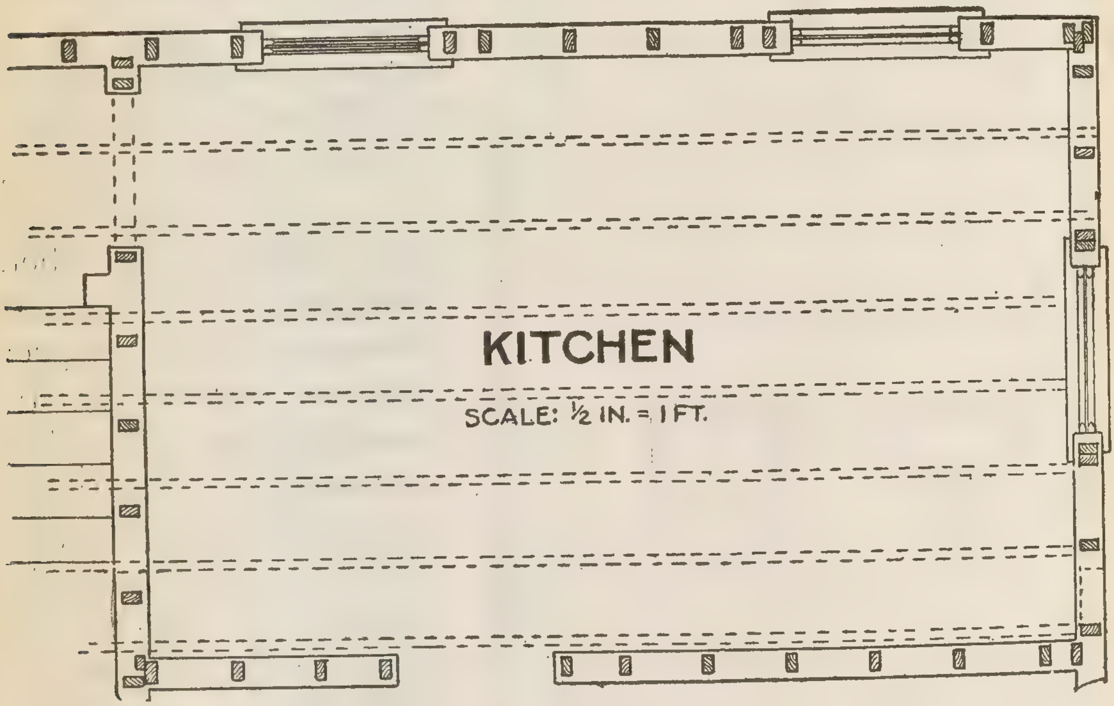


FIG. 6,933.—Plan of kitchen showing frame construction.

For instance in the case of a single floor where a pipe is run at right angles to beams only a plank or two would have to be removed, whereas when run parallel with the beams a considerable amount of the floor must be removed or cut in order to insert the pipe.

Again in the case of a double floor, the labor is the same in either case. However, the amount of labor required in removing or cutting away the floor should not be considered; the chief consideration being to preserve as near as possible the original strength of the beams by locating the fixtures for minimum cutting of beams.

Under cutting of beams will result in sagging floors, cracking and falling of the plaster, and in extreme cases possible collapse of the floor.

With consideration just mentioned in mind, the owners' arrangement of fixtures for the bath room as shown in fig. 6,932 is very unsatisfactory.

Fig. 6,936 shows *how the beams must be slaughtered* to reach the fixtures, For instance 3 beams must be cut to reach the bath tub connections.

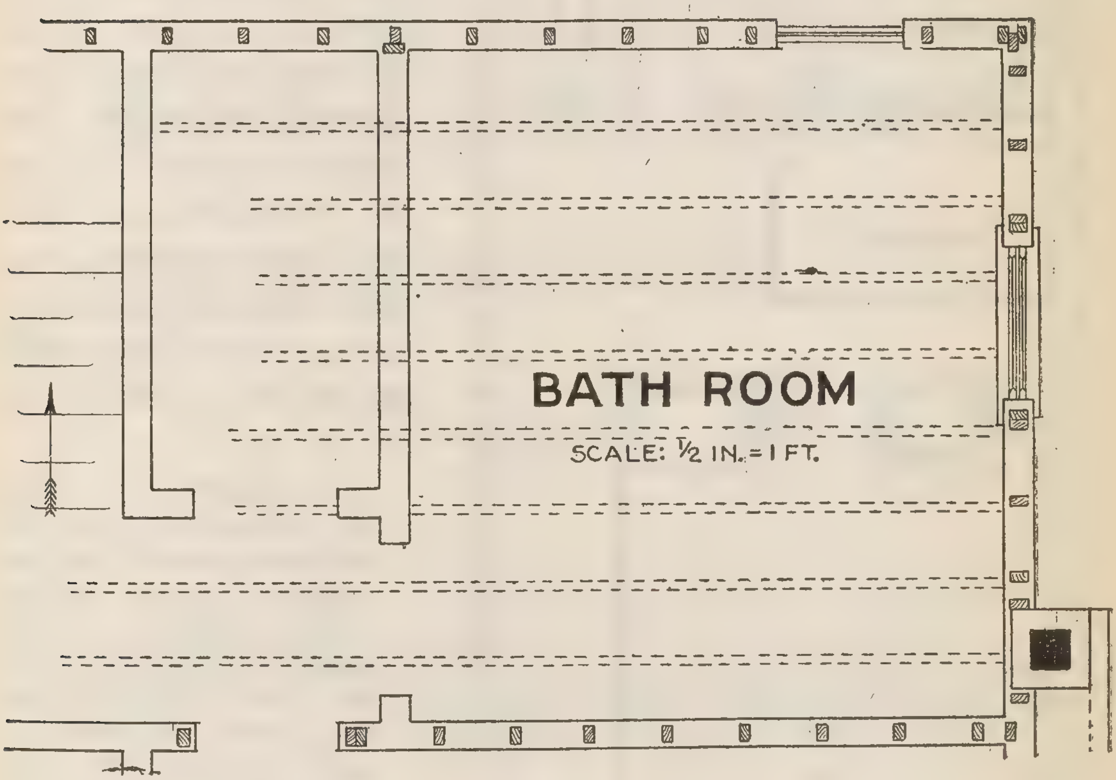
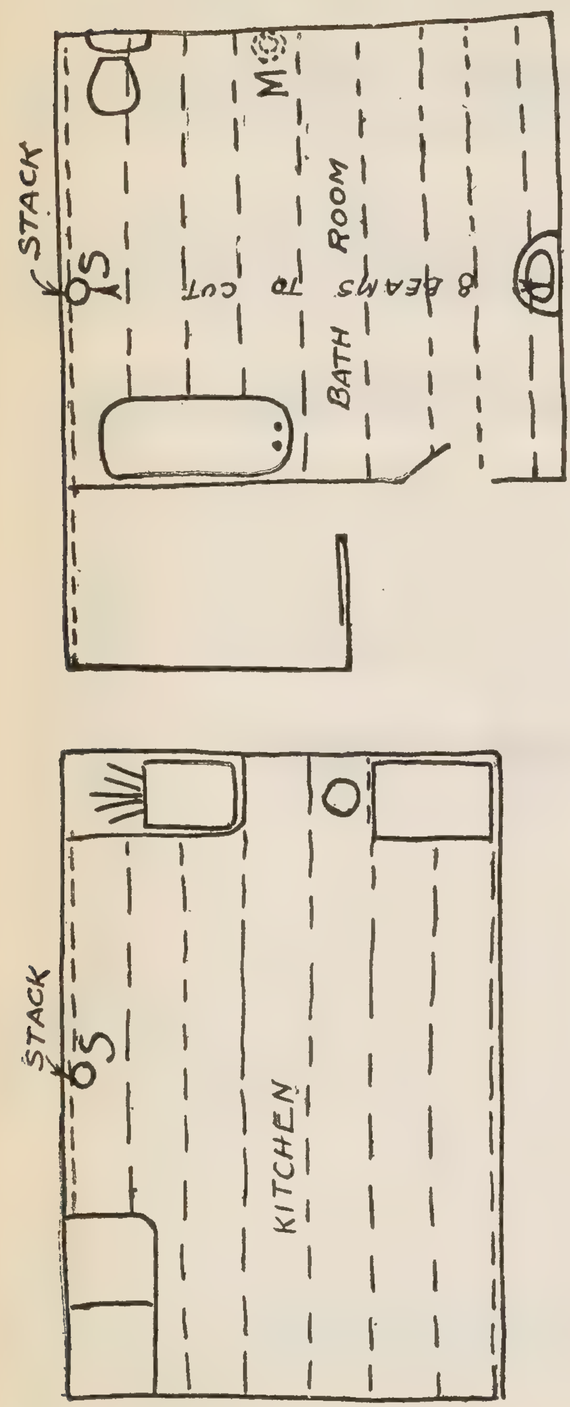


FIG. 6,934.—Plan of bath room showing frame construction.

which, perhaps without reason on part of owner are placed at an end requiring the greater number of cuts. This however does not weaken the beams to any great extent because the cuts are near the ends of the beams where they are supported.

The lavatory is in the worst possible position with respect to the stack



FIGS. 6,935 and 6,936.—Free hand sketches showing location of fixtures as suggested by owner with location of beams in dotted lines and trial location of stack to determine the amount of wood work cutting necessary for roughing in.

because all the floor beams must be cut and at points near the middle of their length.

The plumber should have some knowledge of the strength of beams and is advised to obtain this information by a study of Chapter 28 in the author's Guide No. 2 for Carpenters and Builders, reviewing in the mathematical section any mathematics that may be necessary for a proper understanding of the explanation.

To illustrate the effect of cutting into beams at various distances from the *supports* consider a 2×8 beam having a 15 ft. span and *uniformly* loaded as in fig. 6,937. If the total load be 2,000 lbs. each support will carry

$$2{,}000 \div 2 = 1{,}000 \text{ lbs.}$$

Allowing a *safe shearing stress* on the beam of 500 lbs. per sq. in. *across grain* at the supports, then the required sectional area of beam at support $= 1{,}000 \div 500 = 2$ sq. in.

Since the beam is 2 ins. thick.

depth of beam at support $=2\div2=1$ in.

that is, the beam could be cut away at the support (without decreasing its strength) until there was only an inch (depth) of wood left. It has been found by experiment and calculation that the limit to which a beam may be cut without reducing its strength at any point between the supports, will lie on an ellipse whose major diameter MS, (fig. 6,937) is the span and minor radius LF, the depth *d*, of cut at the supports.

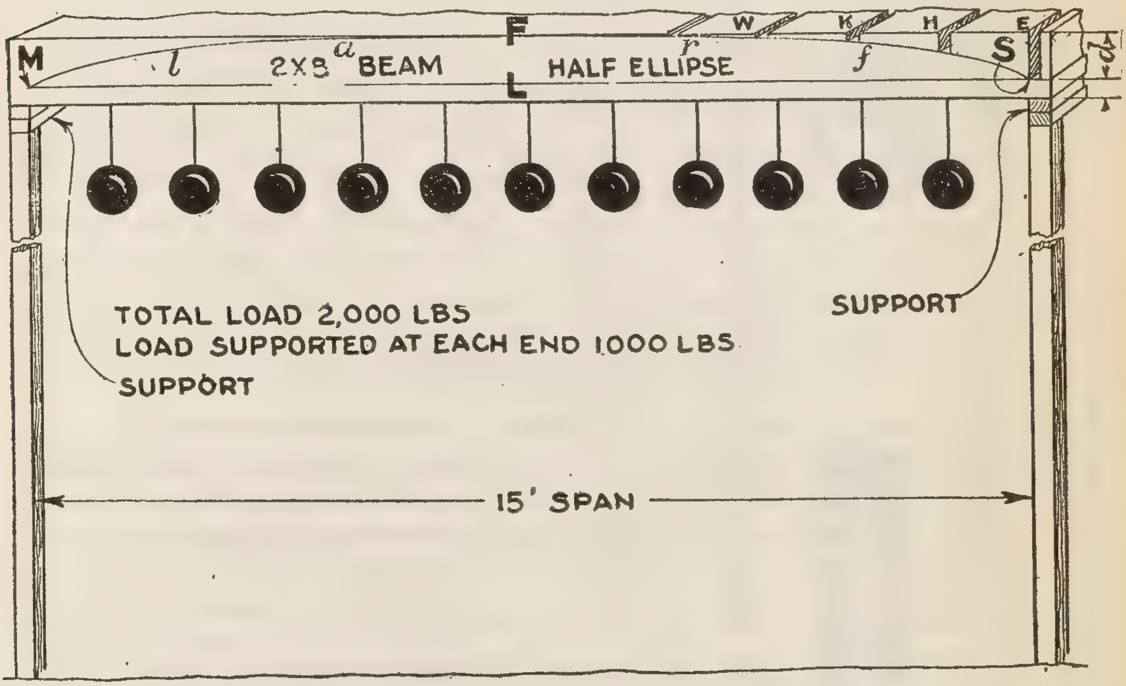


FIG. 6,937.—Uniformly loaded beam illustrating the limit of depth to which the beam may be cut at various points for uniform strength. Cuts as E,H,K,W, for the laying of pipes should not project below the half ellipse *l,a,r,f*, whose major diameter is M,S, equal to the span of the beam, and whose minor radius L F, is equal to *d*, the width of beam less the depth of section below cut E.

In fig. 6,937, half of the ellipse is taken being the curve *l,a,r,f*. It is evident from the drawing that the depth to which the beam may be cut without reducing its strength decreases very rapidly with the distance of the cut from the support as indicated by cuts E,H,K,W, taken at various points between the support and middle of the span thus whereas almost all the beam may be cut away at E, above the support, only about half that amount may be cut at H, a very little distance from the support, and

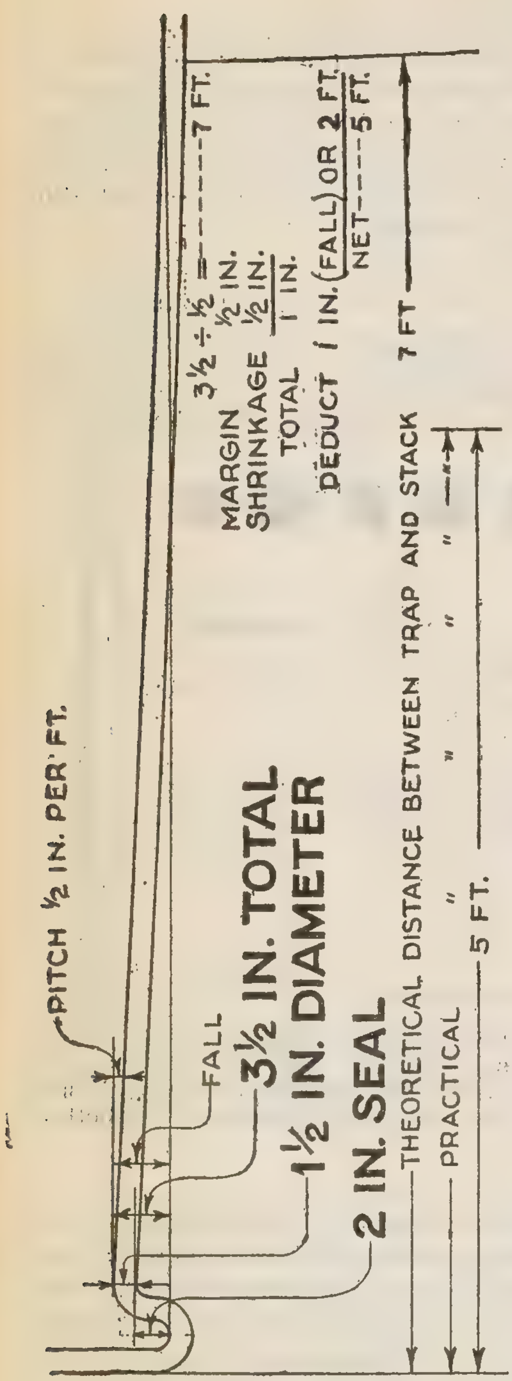


FIG. 6,938.—Limit of distance between an unvented trap and stack where the waste pipe has pitch. ***Formula:*** *maximum distance between trap and stack* = { (*seal*+*diameter of trap*) ÷ *pitch per foot* } − (½ *inch margin*+½ *inch for shrinkage*).

at W, hardly enough to lay a small water pipe. With these properties of beams in mind it can be seen by further inspection of fig. 6,936, how disastrous it will be to the strength of the floor to locate the lavatory as shown, requiring all the beams to be cut and at points near their middle.

To guard against the bursting of pipes by freezing they should have *pitch* so that they may be properly drained without resorting to blowing out when the house is vacant in freezing weather.

Considering that the waste (in fig. 6,936) from lavatory would have considerable length (traversing 8 beams), to obtain the necessary pitch, depth of the cut would increase at each beam from lavatory to stack, considerably weakening the beams especially those near the stack.

Another point to be considered is the limited distance from stack at which an unvented S trap may be used to prevent self-syphonage. Fig. 6,938 illustrates this.

In the figure assume that the seal of trap is 2 ins. and diam-

eter, $1\frac{1}{2}$ making a total of $3\frac{1}{2}$ ins. Now theoretically the trap can be set from the stack at such distance that the waste pipe will have a fall of not more than this distance. In fig. 6,938 if the pitch be $\frac{1}{2}$ in. per foot then the maximum theoretical distance trap can be from stack is

$$3\tfrac{1}{2} \div \tfrac{1}{2} = 7 \text{ ft.}$$

In practice the fall of the pipe could not be carried to this limit, that is, made equal to seal + trap diameter, because the water in the trap would be exactly balanced by the water in the waste pipe and the trap would be easily syphoned by any sagging of the waste pipe or any other causes. Accordingly deduct $\frac{1}{2}$ in. from fall to allow for this.

Again *when shrinkage of the floor beams takes place* the weight of the tub will press down the waste pipe causing it to be depressed $\frac{1}{4}$ in. or more and according $\frac{1}{2}$ in. should be allowed for this making a total deduction of 1 in. from the fall. Since the pitch is taken at $\frac{1}{2}$ in. per foot this is equivalent to deducting 2 ft. from the theoretical distance or

$$7-2=5 \text{ ft.}$$

Of course, the waste pipe could be run at less pitch than $\frac{1}{2}$ in. per ft. but such practice is not to be recommended. A better method would be to install a trap with a deeper seal than to reduce the pitch.

On long runs the effect of momentum of the water in the waste pipe during operation of the trap should be considered and say an extra half inch of fall deducted to avoid possibility of the water being syphoned from the trap due to the momentum of the water flowing in the waste pipe.

Considering now the owner's location of the closet (fig. 6,936) this requires cutting one beam, and introducing an extra 90° turn in the soil line between closet and stack.

The plumber may make another trial position of the stack by locating it at say position M, shown in dotted lines.

While this will result in less cutting of beams it necessitates long waste lines to bath and lavatory which as just explained are impossible with ordinary non-vented S traps, the kind now being considered.

Evidently a rearrangement of the fixtures is necessary for simplicity and economy of material and labor, also to avoid weakening the building.

The location of the fixtures in the kitchen presenting no mechanical difficulties in installation and being convenient for owner's use may be regarded as fixed. Hence in a rearrangement of the fixtures in bath room the stack is located in best position for connection with the kitchen fixtures, and the bath room fixtures located where the connection can be more easily made with the stack.

Accordingly let position S, of stack in fig. 6,935 be approximate location of stack in making a new arrangement of fixtures in bath room. Since ordinary non-vented S traps are to be used, both the waste to the bath

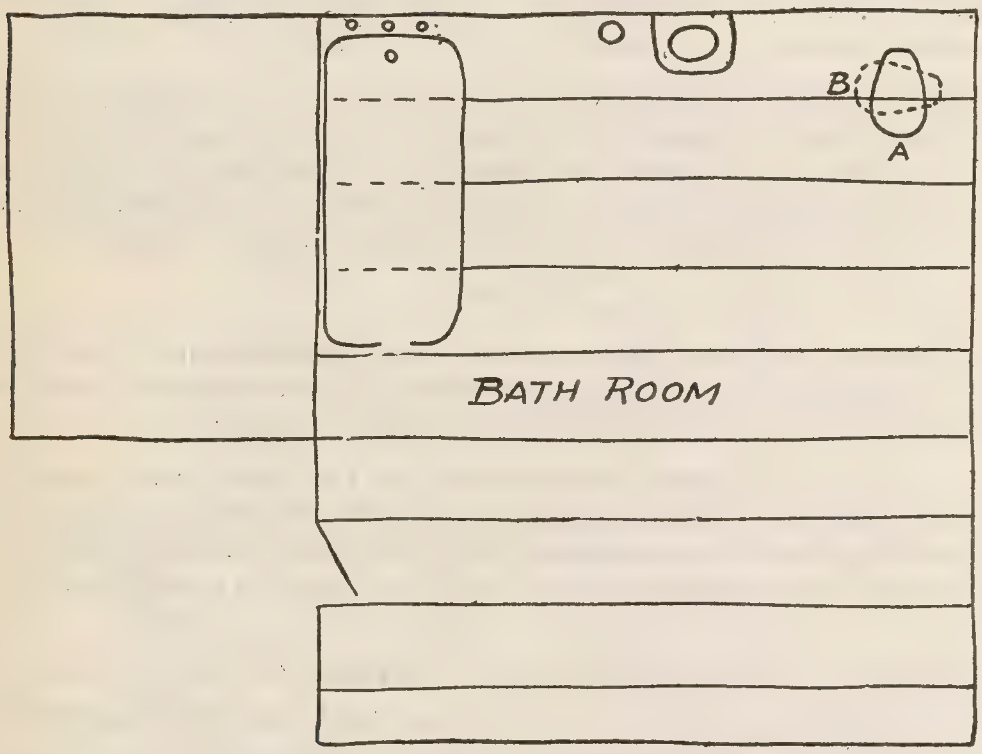


FIG. 6,939.—Plumber's proposed arrangement of bath room fixtures for minimum roughing in work and best drainage.

tub and to lavatory should be taken from the soil pipe at higher levels than the closet outlet, to prevent their traps being syphoned by the discharge of the closet. There is no danger of the closet being syphoned by discharge of the other fixtures because the stack is so much larger than the waste pipes no solid slugs of water will be possible in the stack.

In order to avoid cutting beams, arrange fixtures so their outlets will be on the side of room next to stack. Turn bath tub around so its outlet will face this side as shown in fig. 6,939. Since the outlet of lavatory is above the floor level, place lavatory next to stack which permits concealing its waste pipe without cutting an unnecessary number of joists; this will also

give room to get closet connection below waste from tub. The arrangement is indicated as in fig. 6,939.

In case it be necessary to cut a beam to place closet in position A, this can be avoided by turning it around to position B, shown in dotted lines. The owner's consent to this arrangement should now be obtained and the roughing in work started.

Layout for the Roughing In Work.—In designing any drainage system, special consideration should be given to the arrangement of the piping so as to have

1. Direct waste lines.
2. Easy bends rather than short turn elbows.
3. Proper pitch to prevent water pockets.
4. Least number of joints.
5. Accessible location to avoid difficulties in installing and repair.

A thorough knowledge of soil pipe and all the various fittings is necessary to intelligently work out the best arrangement for any roughing in job. In this connection the following trade customs and regulations should be noted in ordering.

1. Always state kind of pipe and fittings; whether standard, medium, or extra heavy.

2. Goods are usually tarred unless otherwise ordered.

3. To determine right or left sides of a fitting, place same in caulking position and face hub.

4. State whether 5 or 6 ft. lengths of pipe are required.

In regard to these items standard pipe is too light for a safe job, and extra heavy, is unnecessarily heavy. The medium pipe is about the right weight for house installations.

The coating of asphaltum on the pipe is to prevent corrosion and to fill up any sand holes, flaws or other defects that may have occurred in the manufacture.

Defects may be detected by tapping the pipe with a hammer. If the pipe be of good material and without defects the sound will be clear and distinct; if cracked, split, etc., the sound will be muffled and harsh.

There are two methods of doing the roughing in work.

1. "By eye" and rough measurements.
2. Entirely by measurements.

The first method is a hit or miss process—especially miss in the case of a beginner or greenhorn and accordingly should only be attempted by an experienced plumber.

The second method is one of precision and is the better way.

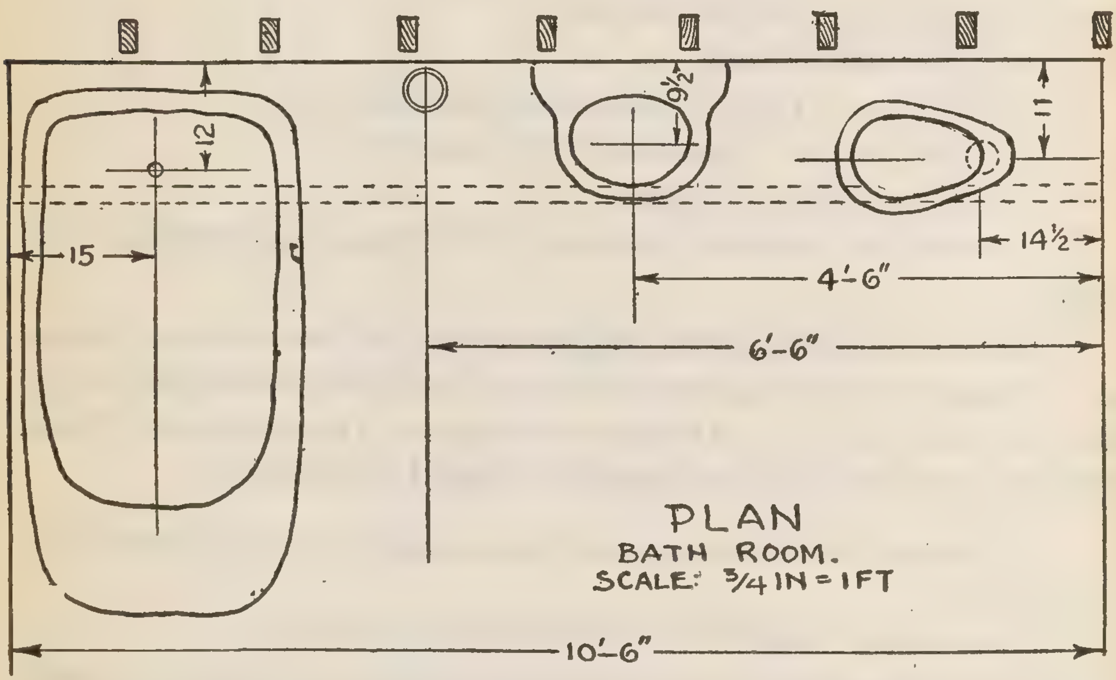


FIG. 6,940.—***Plan*** of bath room showing location of fixtures as obtained from roughing in measurements; distances side wall to outlet centers. The reader should understand the difference between a ***plan*** and an ***elevation***.

Sometimes a combination of both methods will save time.

Disregarding the "by eye" or slip shod method and to illustrate the second method of roughing in, first, in the absence of the architect's drawings make "*skeleton sketches*" as required.

Since the proposed position of stack may be shifted more with respect to the kitchen fixtures, than with respect to the bath room fixtures, measure up the bath room first and make skeleton *plan* as in fig. 6,940 to scale say ¾ in. = 1 ft.) and sketch in the fixtures, from the roughing in measurements,

locating stack between tub and lavatory. This sketch should be made along with the *elevation* fig. 6,942, drawing both sketches at the same time. A clear idea of what these sketches are intended for should be kept in mind and no unnecessary detail drawn. They are made simply to locate center lines and fixture outlet positions and may be regarded as preliminary to the detail sketches which follow.*

Follow some regular order in transferring the roughing in measurements that is, show in the plan, fig. 6,940 distances of fixture outlets from side of room, and in the elevation, distances from center of stack after the latter has been located. The stack should be so located that the waste lines for sink and tubs in kitchen are as near the same length as possible to avoid

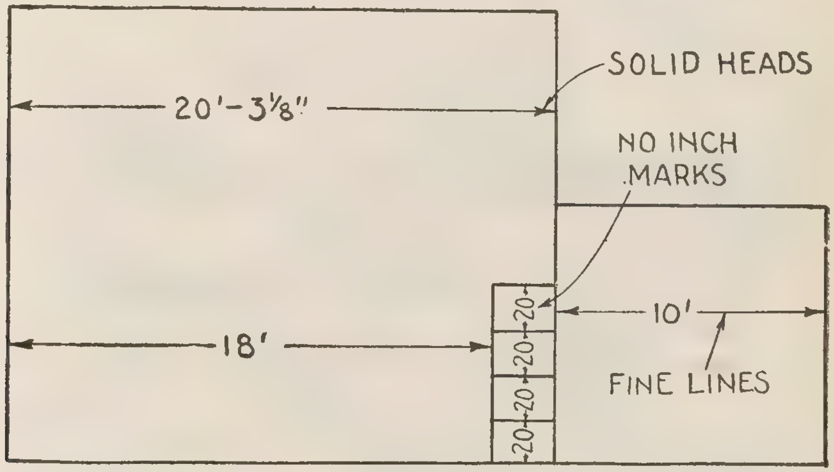


FIG. 6,941.—Method of dimensioning drawings as preferred by the author. ***Note,*** solid arrow heads that can be seen; fine dimension lines which by contrast are not confused with the lines of the drawing; no inch marks where dimension is in inches only.

long waste lines; this will bring the stack about as shown in fig. 6,942. The plan and elevation just completed are drawn on too small scales to accurately show the piping hence it is necessary to make larger drawings laying off the center lines according to the measurements obtained in figs. 6,940 and 6,942.†

*NOTE.—Unless you wish to be considered a greenhorn as a draughtsman never fail to state on each sketch whether it be a *plan* or *elevation* in large letters (as in figs. 6,940 and 6,942) and also the scale. The proper time to do this is when beginning the sketch.

†NOTE.—They should know how to make a drawing "to scale" as fully explained in the author's Carpenters' and Builders' Guide No. 2 in the chapter on Practical Drawing.

†NOTE.—The scales indicated on the drawings refer to the *original drawings* and ***not*** to the reproductions of same here shown as these are considerably reduced in size.

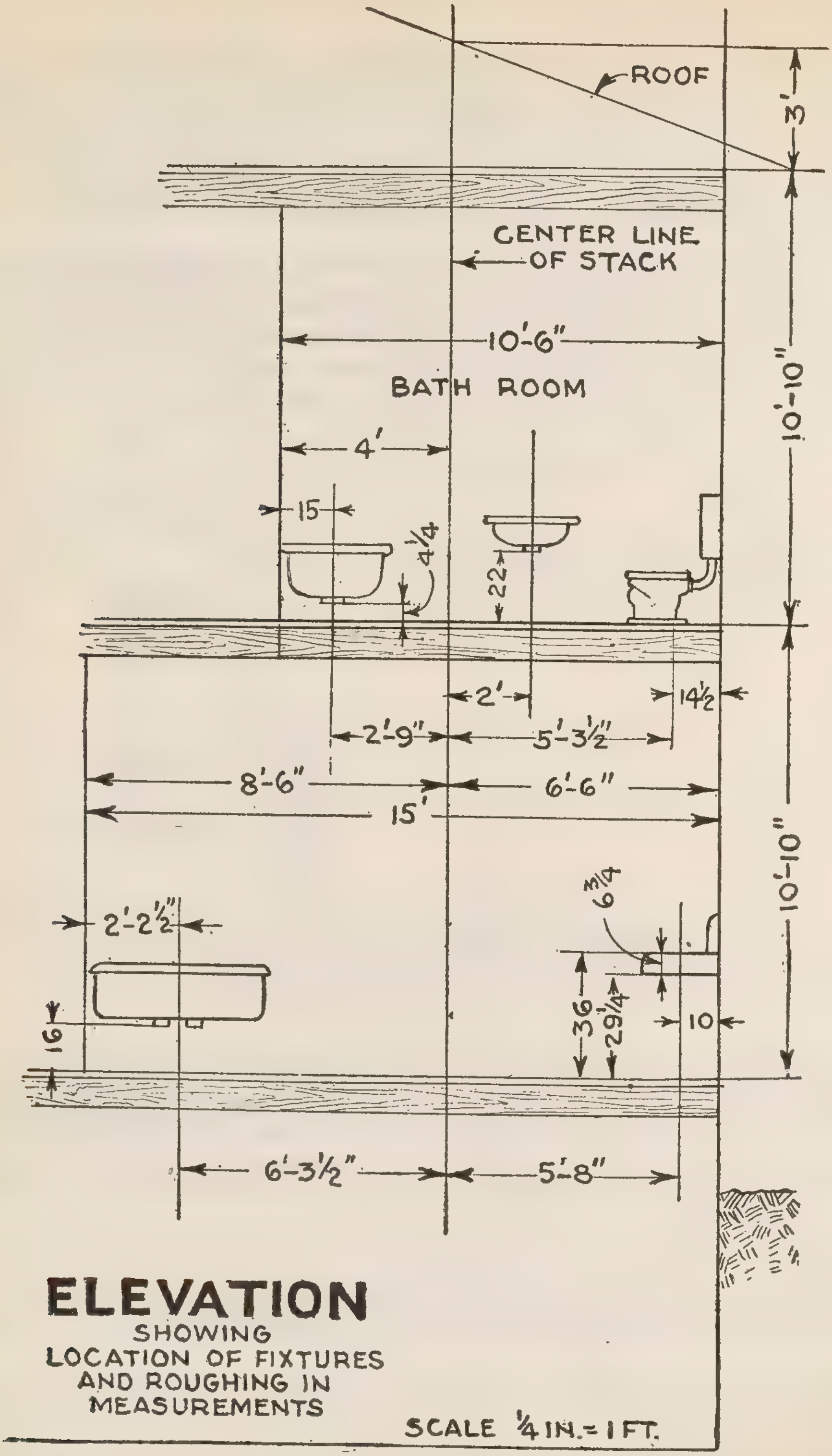


FIG. 6,942.—***Elevation*** of house showing location of fixtures as obtained from roughing in measurements; distances of outlet centers from stack center line, etc.

Of course the larger the scale of the drawing, the greater the precision. Thus the 1″=1′ and 1½″=1′ scales read to ¼ inch; the 3″=1′ scale, to ⅛ inch. Unless the plumber be an expert draughtsman he should not attempt to lay out piping installations on too small a scale; better not attempt it on a scale less than 3″=1′. This scale 3″=1′ is the same as saying ¼″=1″, or 1″=4″, that is the drawing when completed will be one quarter as large as the original.

Do not expect to make an accurate drawing by using a

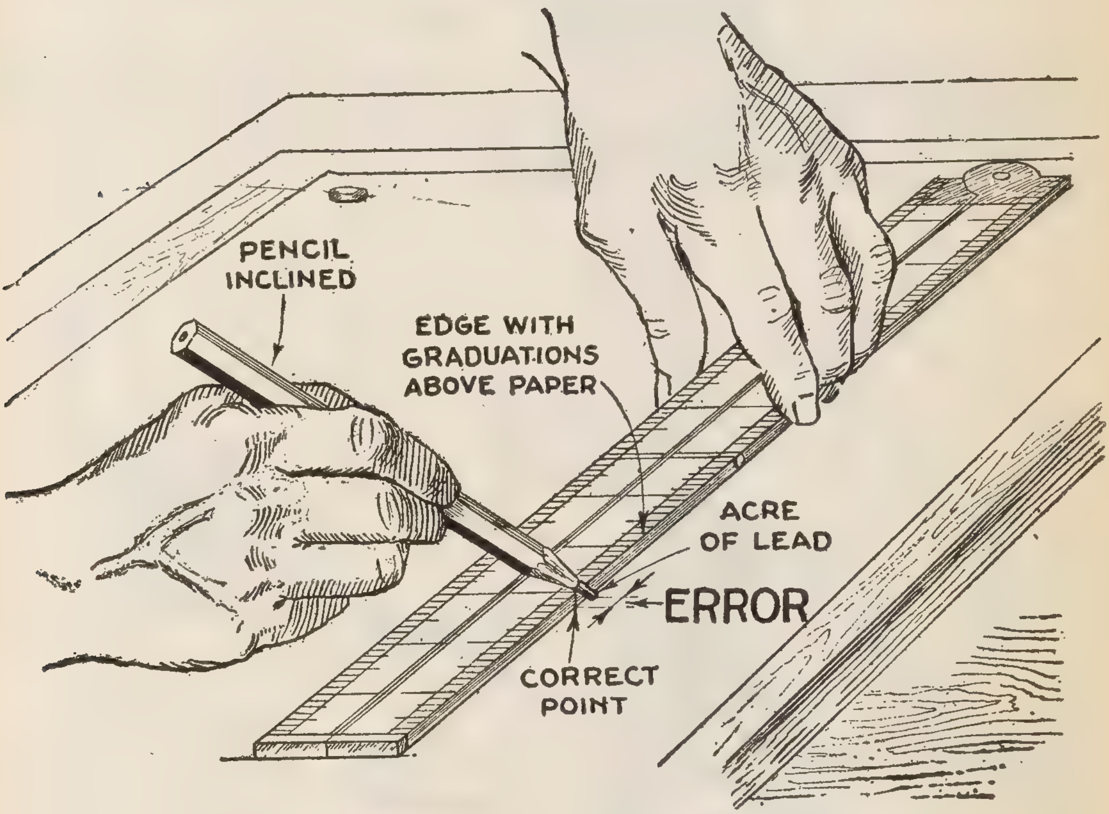


FIG. 6,943.—Result of trying to make a drawing to scale with a carpenter's 2 ft. rule and a pencil with an acre of soft lead for a point.

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*NOTE.—***All figured dimensions*** on drawings must be in plain, round vertical figures, not less than one-eighth inch high, and formed by a line of uniform width and sufficiently heavy to insure printing well, omitting all thin, sloping or doubtful figures. All figured dimensions below two feet are best expressed in inches. It is not necessary to put down a multiplicity of inch marks (″)—these can well be left off, using the foot and inch marks only when the dimension is expressed in feet and inches. This will save time and improve the appearance of the drawing. It may be put down as a rule that the draughtsman must anticipate the dimensions which will be looked for by the workman in doing the work, and these dimensions only must be put on the drawing.

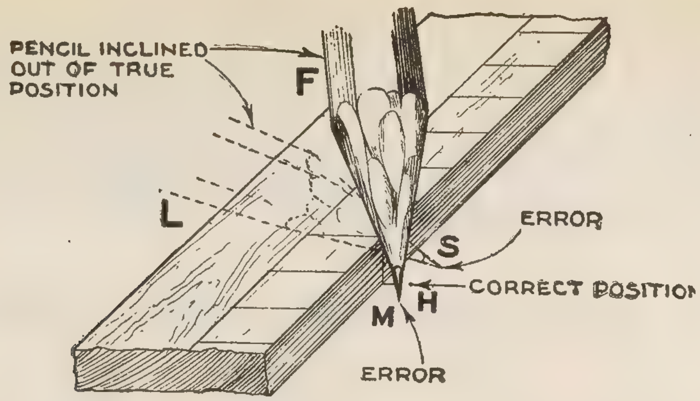


FIG. 6,944.—Enlarged view of fig. 6,943, showing effect of the elevated edge of rule even when a sharp pencil is used. If the pencil be inclined to either side as positions L and F, the points obtained will be M and S, instead of the correct point H; these errors may represent ½ inch or more in the length of a pipe according to the scale used, so how could it be expected to cut pipe in the shop from a drawing thus made and have it fit when assembled?

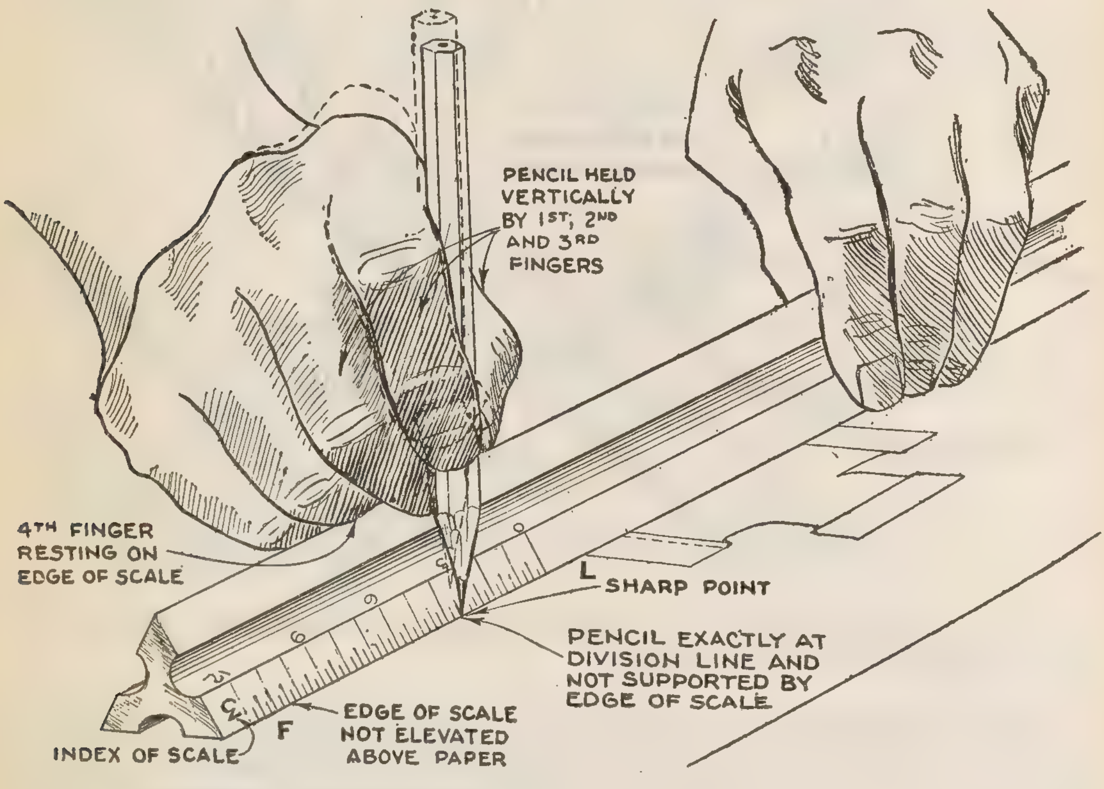


FIG. 6,945.—Precision method of marking off distances on a drawing by use of architect's boxwood scale and pencil having a sharp point and reasonably hard lead. The draughtsman is here shown marking off a distance of 3½ inches using the scale: 3″ =1′. Observe that the pencil is held vertically by the 1st, 2nd and 3rd fingers with the 4th finger resting on the top edge of the scale. The divisions between L and F represent inches and fractional inches. From L (toward the right) only feet divisions are marked on scale.

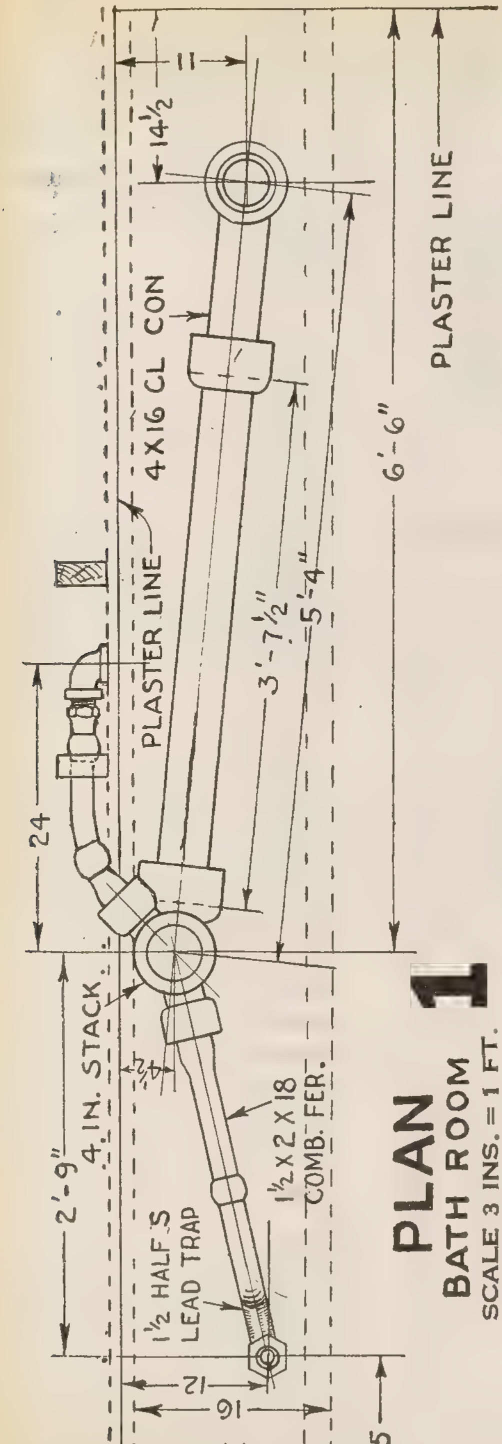


FIG. 6,946.—Plan of roughing in for bath room showing dimensions.

carpenter's 2 foot rule and a pencil *with an* ***acre*** *of soft lead* for a point as in fig. 6,943, it can't be done.

The enlarged view, fig. 6,944 shows errors even with a sharp pencil due to supporting the pencil on an elevated edge of the rule and holding pencil in an inclined position. Compare this with the method of precision shown in fig. 6,945. With these points clearly understood, enlarge to $3'' = 1'$ scale plan and elevation of the bath room as shown in figs. 6,940 and 6,942.

Since the scale is $3'' = 1'$, and length of room is $10' - 6''$ then the net length of paper required for the plan is $10.5'' \times 3 = 31.5$ ins., and allowing a little margin at sides take a sheet of paper 34 ins. long; its width need be only enough to take in bath tub with a little margin. This width (scaling on fig. 6,940) is say 8 ft. And for the $3'' = 1'$ scale, width of sheet is $8 \times 3 = 24$ ins.

Now enlarge the plan from fig. 6,940 and the elevation on another sheet.

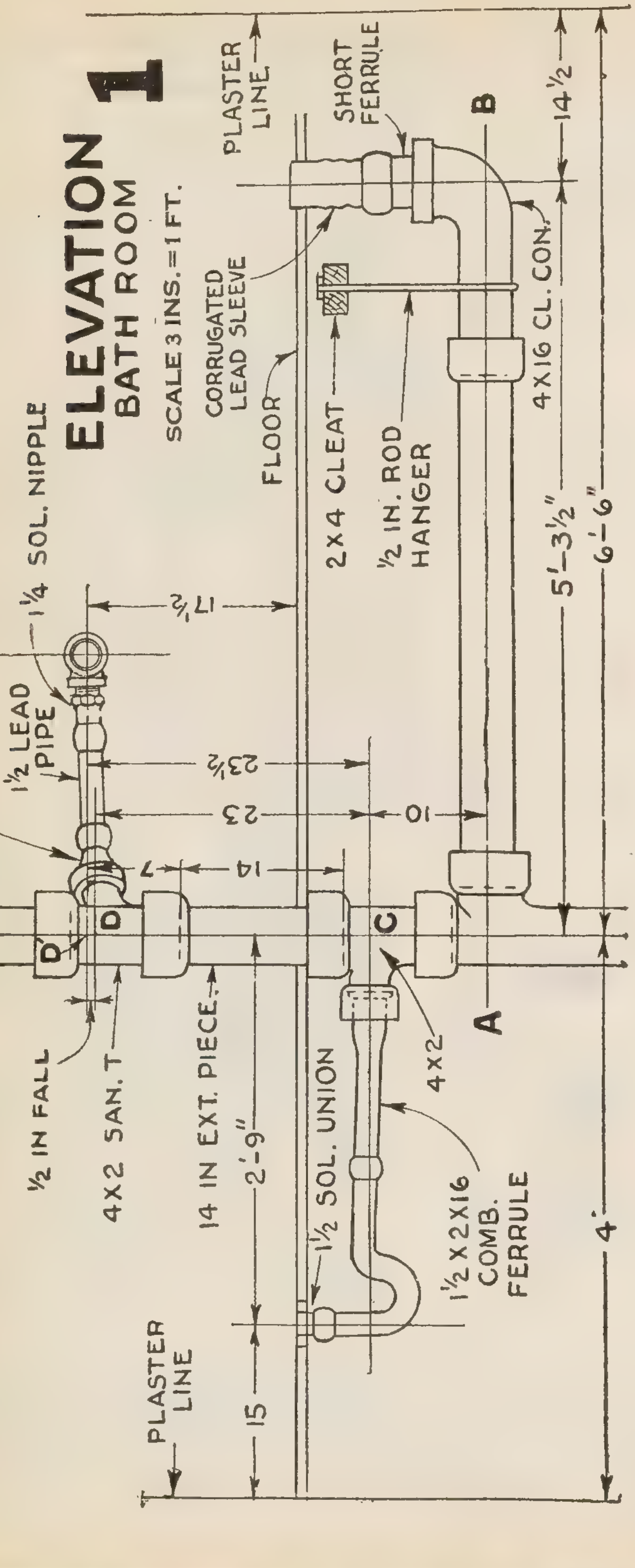


FIG. 6,947.—Elevation of roughing in for bath room showing dimensions.

Next sketch in the best arrangement of piping and fittings and put in dimensions as in figs. 6,946 and 6,947.*

In drawing in the fittings, it would be a useless waste of time to show the hubs in full detail, simply draw a rectangle of approximately correct depth rounded at the bottom. The important operation is to properly locate the ***dotted lines*** *hh'* and *dd'* (fig. 6,950) which represent the bottom or face of the hubs upon which the spigot end of the next fitting or pipe rests; that is, these dotted lines are the *telescoping limits* and are the lines from which laying measurements are taken. These dotted lines (and the center lines) are in fact the only lines which need to be accurately

*NOTE.—It should be understood that these two drawings are made at the same time, that is, each detail is first sketched on one drawing then on the other. In making these drawings it should be understood that the laying length of a fitting or length of pipe is *the overall length less the telescoping*, this is illustrated in fig. 6,948,

drawn, the outline of fittings and pipe may be drawn free hand if desired to save time. The following instructions for drawing the sanitary T shown in fig. 6,950 will serve as a general guide for drawing all fittings.

Fig. 6,949 shows the T branch in full detail and the reference letters for dimensions correspond to similar letters in fig. 6,950. These letters refer to the actual dimensions of the fitting for all the various sizes as given in the following table:

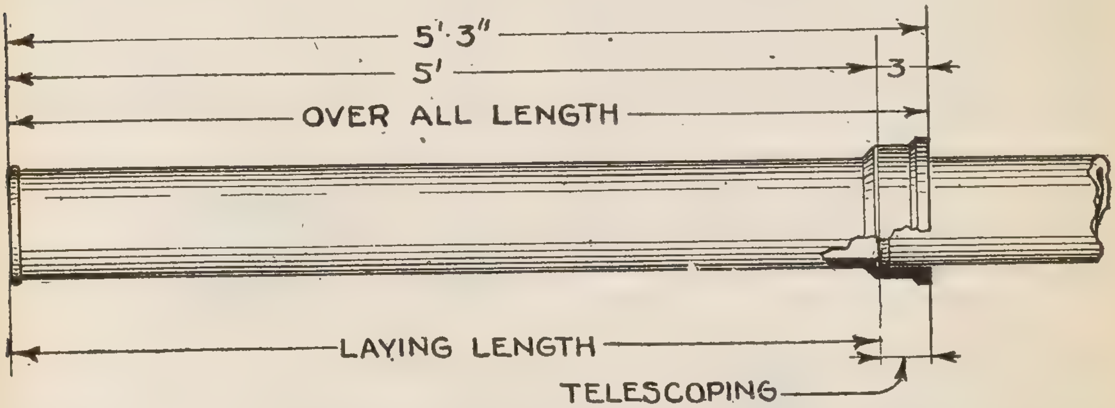


Fig. 6,948.—Length of four inch soil pipe showing difference between the overall length and the laying length. ***It is the laying length*** that is used in taking dimensions or drawing to scale, also in designating pipe lengths; that is, the standard length of soil pipe is five feet whereas its actual or overall length for, say, a 4" pipe is 5'-3", the three inches being taken up by the *telescoping* of the hub. Since the telescoping adds nothing to the length of the line it is disregarded.

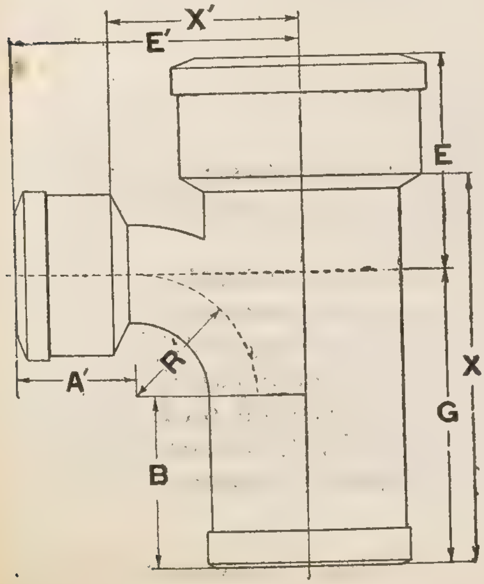


Fig. 6,949.—Sanitary T (branch*) in full detail. Evidently in making roughing in layout it would be a foolish waste of time to draw the fittings in full detail as here shown when the simple representation shown in fig. 6,950 will answer the purpose.

*NOTE.—The author ***objects*** to the use of the word "branch" as commonly applied to Ts, Ys and other fittings, as such application is ***superfluous*** and therefore ***ridiculous.***

Dimensions for Sanitary T

Size Inches	A	B	E	E′	F	G	R′	X	X′	Weight Pounds
2	3	4	4½	6	11½	7	3	9	3½	11
3	3¼	4	5¼	6¾	12¾	7½	3½	10	4	16¼
4	3½	4	6	7½	14	8	4	11	4½	22½
5	3½	4	6½	8	15	8½	4½	12	5	28
6	3½	4	7	8½	16	9	5	13	5½	34½
3x2	3	4	4¾	6½	11¾	7	3	9	4	14
4x2	3	4	5	7	12	7	3	9	4½	17¼
4x3	3¼	4	5½	7¼	13	7½	3½	10	4½	19¾
5x2	3	4	5	7½	12	7	3	9	5	20
5x3	3¼	4	5½	7¾	13	7½	3½	10	5	23
5x4	3½	4	6	8	14	8	4	11	5	25½
6x2	3	4	5	8	12	7	3	9	5½	23
6x3	3¼	4	5½	8¼	13	7½	3½	10	5½	26
6x4	3½	4	6	8½	14	8	4	11	5½	29
6x5	3½	4	6½	9½	15	8½	4½	12	5½	31½

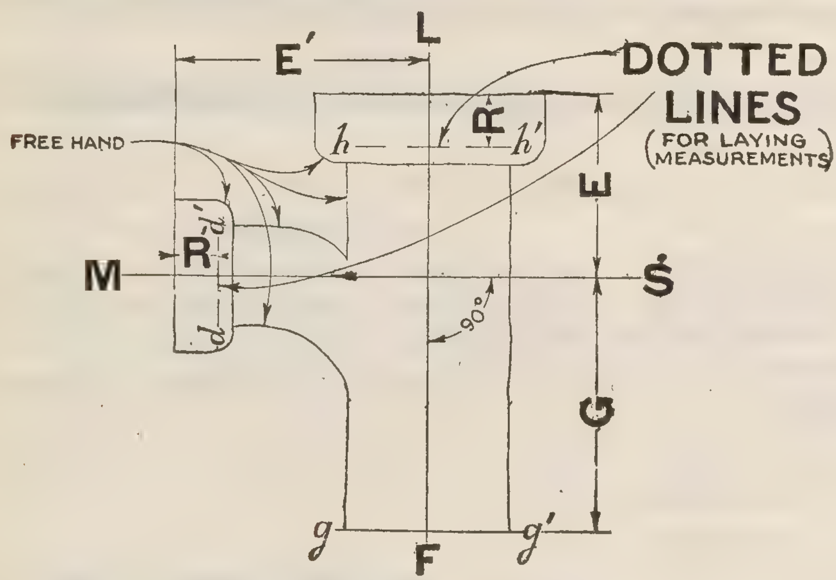


FIG. 6,950.—The author's method of drawing soil fittings to avoid waste of time as explained fully in the text. The important lines are the dotted lines *hh′*, *dd′*, and *gg′*; these lines should be located and drawn with precision, all the rest may be put in free hand.

To draw the T, fig. 6,950, first draw (in very fine lines) the axes MS and LF, at right angles, or 90° to each other. Suppose the size of T is 4×2 (as for instance the 4×2 T connecting bath waste to stack fig. 6,947). Look in above table column of sizes for 4×2 and in the same horizontal line under column E, find dimensions for E, to be 5 ins. Lay off on LF, from the intersection of the axes, E = 5 ins.; similarly on MS, E′ = 7 ins. Draw lines through these points to represent ends of hubs. These lines must be accurately drawn.

Now the distance the faces *hh′* and *dd′*, are back of these lines depends

upon the size of opening, that is, depth of hub or amount of telescoping is as follows:

Size of pipe..........	2	3	4 to 6 ins.
Amount of telescoping	2½	2¾	3 ins.

Accordingly (in fig. 6,950) measure back R=3″ for *hh′* and R′=2½ ins. for *dd′*, since the openings are 4 and 2 ins. respectively. Draw lines a little back of *hh′* and *dd′* to represent back end of hub and complete hubs and branch connection in free hand.

Find in table value for G, which is 7 ins. Measure off on LF, 7 ins. from intersection of axes given location of spigot end *gg′*. This line *gg′* must be accurately drawn, although the sides may be drawn free hand. This is the simplest and quickest method of drawing fittings with exception of the author's fully abbreviated system shown in fig. 6,961.

In drawing the sides, take diameter ½ in. greater than listed size which allows ¼ in. thickness of metal. The diameter of hubs can be gauged by eye, or ascertained from a table similar to above given dimensions for hubs. Complete tables for all fittings are given in the chapter on soil pipe and soil pipe fittings.

In order to avoid considerable waste of time and a poor drawing the following outfit is essential: Scale, dividers, drawing pencil of proper hardness, T square, triangles, drawing board and thumb tacks.

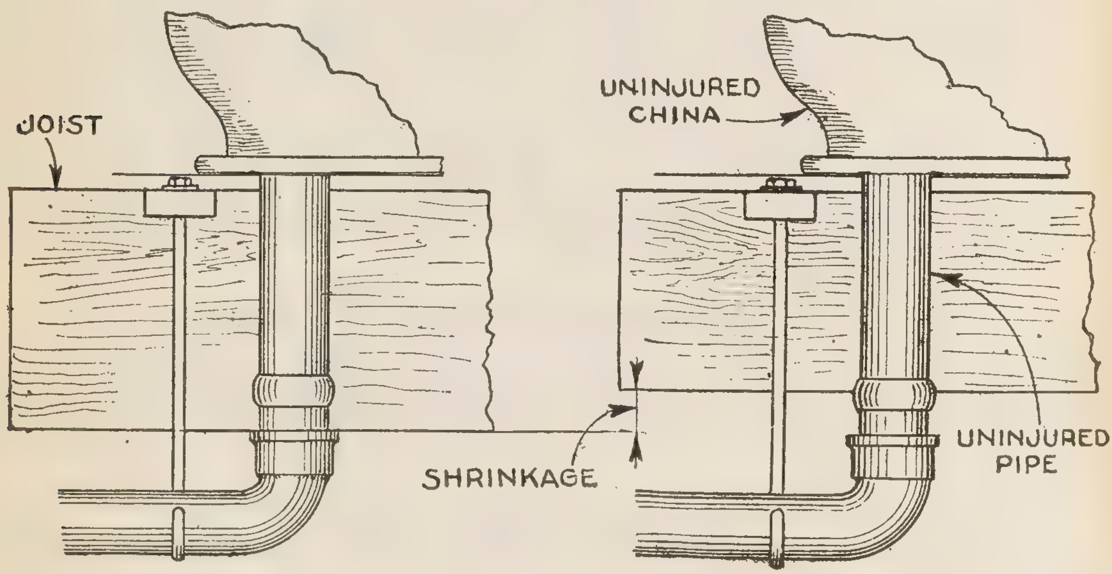
In drawing the *plan* for bath room (fig. 6,946) represent wall surface by the full lines and show in dotted lines two beams 16 in. centers.

Locate stack and closet outlet center and draw sanitary T and a 4×16 closet connection. This leaves a distance of 3′−7½″ between the T and closet connection and complete line with a double hub pipe cut to required length as shown. Show branch of 4×2 T leading to bath tub waste and complete line with 1½×2×18 combined ferrule with wipe joint connection to a half S lead trap.

Similarly for the lavatory drain branch, another 4×2 T, with line consisting of short ferrule, connected by wipe joint to lead pipe with the other end connected to solder union and steel elbow. Note that the studding is represented by pairs of dots, two being drawn in full, showing that only one stud need be cut to conceal the lavatory line back of wall. This completes the plan, but it does not show all the fittings on the stack line and gives no indication of the elevations.

To get these relative heights of the fittings an elevation must be drawn as in fig. 6,947.

First start with the closet. The distancc between base of closet and the closet connection will depend upon the method in which this fitting is connected to the closet. The type closet selected has a cast brass floor flange with asbestos ring gasket arranged for lead pipe connection. This means that there must be a short length of lead pipe and short ferrule between the base of closet which rests upon the floor and the cast iron elbow fitting called the closet connection.



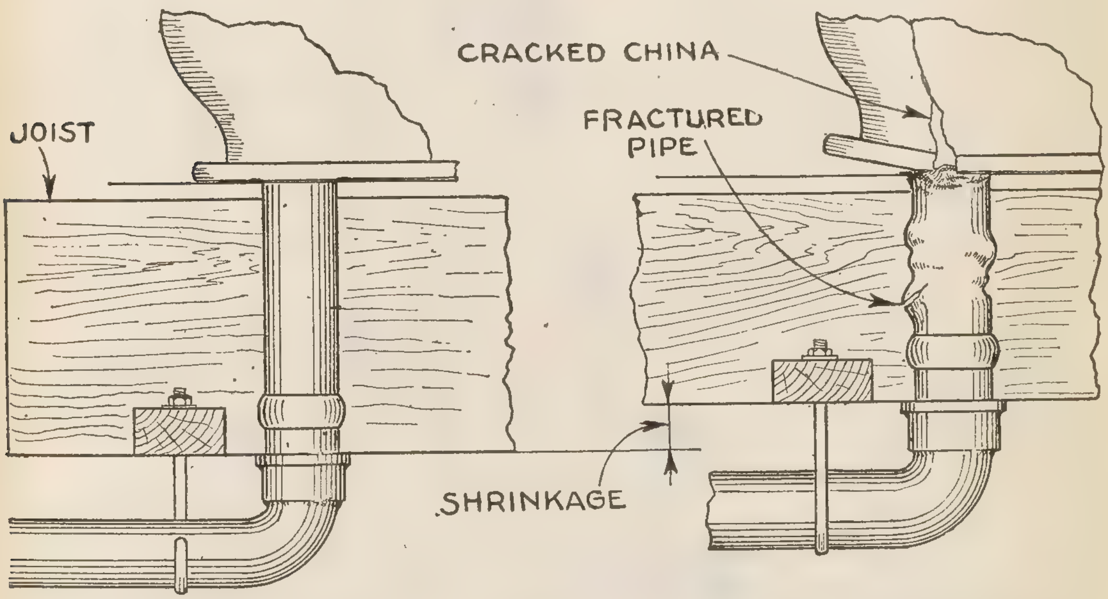
FIGS. 6,951 and 6,952.—Right way to support closet connection. Supports should be attached as near the top of the beam as possible to avoid the effect of shrinkage which tends to push up the closet.

By trial it is found that the necessary distance between base of closet and closet connection is too great to permit placing the latter between the floor and ceiling. Accordingly, after drawing line to represent floor beam and axis sketch in a 4×16 closet connection below ceiling in kitchen as shown. Connect with this a short ferrule, and length of lead pipe, the end of which connects with the closet outlet. Since wood shrinks mostly across grain, support the closet connection by a rod hanger fastened to a cleat placed as high up as possible. This provision together with the softness of the lead pipe will prevent any damage due to shrinkage. If it be necessary to secure the hanger lower down, the old fashioned corrugated lead pipe should be used to permit movement of the pipe due to shrinkage.

Figs. 6,951 and 6,952, show how damage may result from shrinkage when not provided for.

The actual elevation of the closet connection depends not only on the necessary distance to closet, but also upon the proper elevation of the T serving the bath waste (fig. 6,947).

Hence, draw center line and locate C, elevation of sanitary **T** connecting with bath waste. It happens that this comes at the proper elevation for the bath trap, otherwise the elevation of the closet connection must be shifted up or down to bring C, at the proper elevation. Next locate D, at proper elevation to connect with waste line from lavatory.



Figs. 6,953 and 6,954.—Wrong way to support closet connection and resulting damage to closet due to shrinkage.

Since the distance between the bath and lavatory T is less than the standard pipe length, use is made of a fitting called an *extension piece* to join them.

An extension piece is virtually a pipe unit shorter than the standard length and can be obtained in any length (varying by 2 ins.) from 4 to 36 ins. Use an extension piece if possible rather than a cut piece of pipe to length, because it saves the labor of cutting and avoids the possibility of a botch job due to the absence of a spigot.

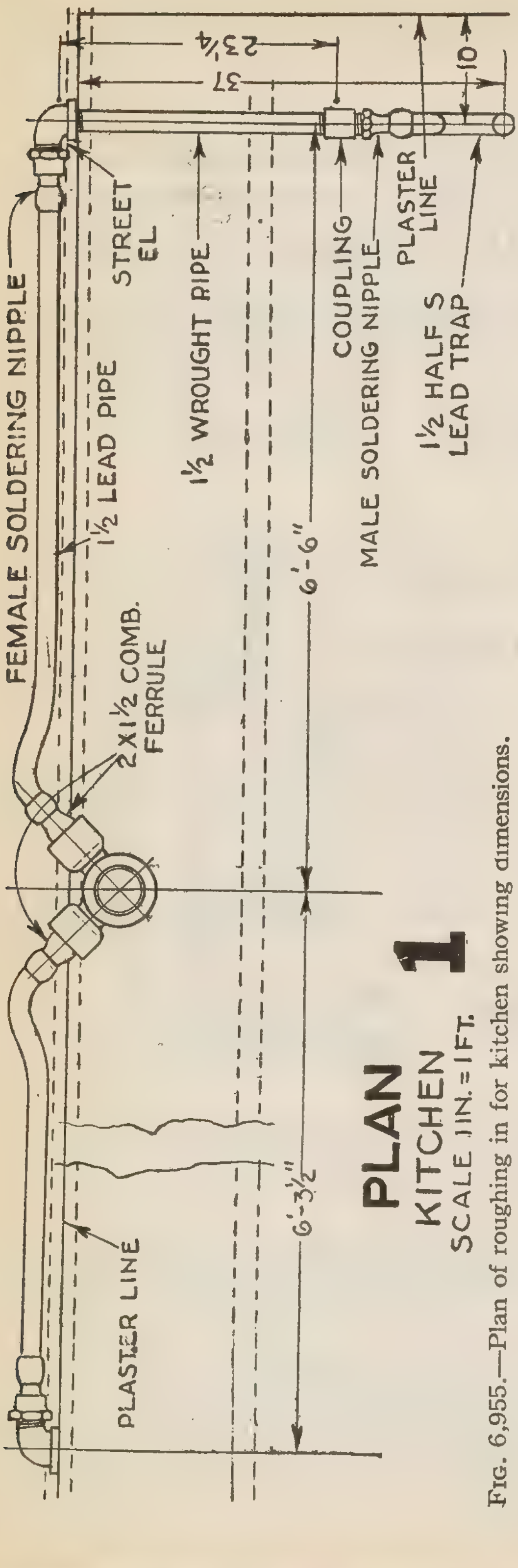


Fig. 6,955.—Plan of roughing in for kitchen showing dimensions.

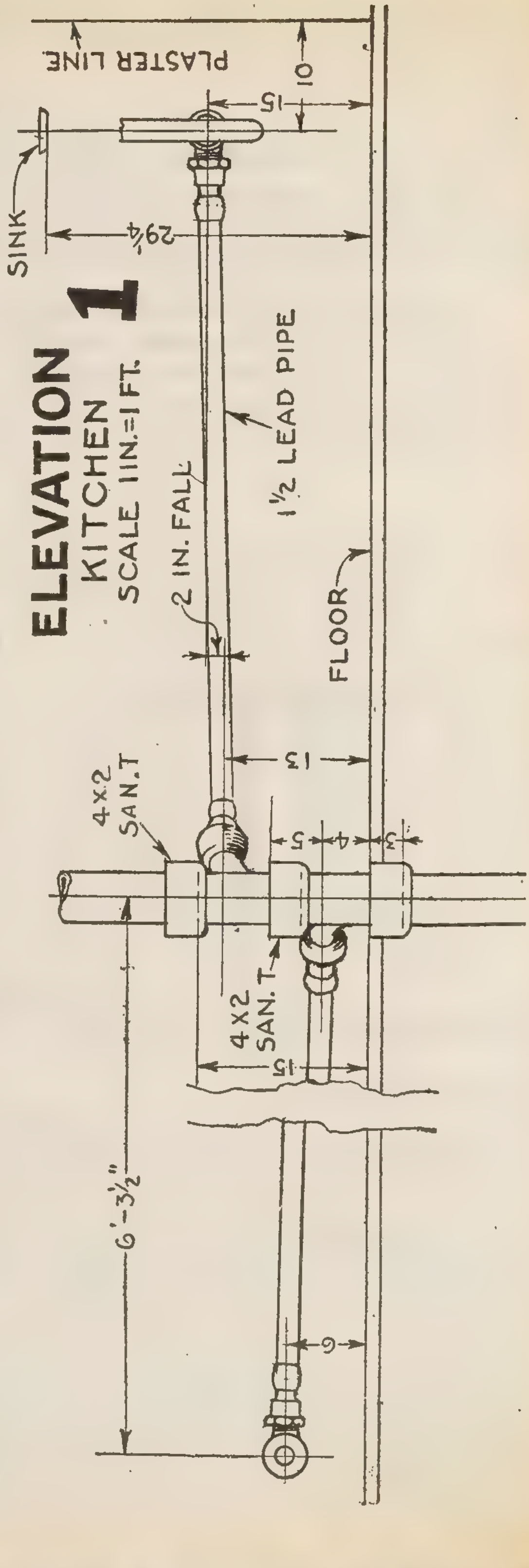


Fig. 6,956.—Elevation of roughing in for kitchen showing dimensions.

The lavatory trap outlet is 17½ ins. above floor line. Draw the horizontal center line cutting the stack axis at D′.

Now by measurement the distance between C and D′ is 23½ ins. The distance between the lavatory and bath Ts, (assuming lavatory waste to be horizontal) is as follows:

Distance CD′		23½ ins.
" C to hub face (dotted line)	2	
" D to spigot end	7	
	9	9
Distance between Ts		14½ ins.

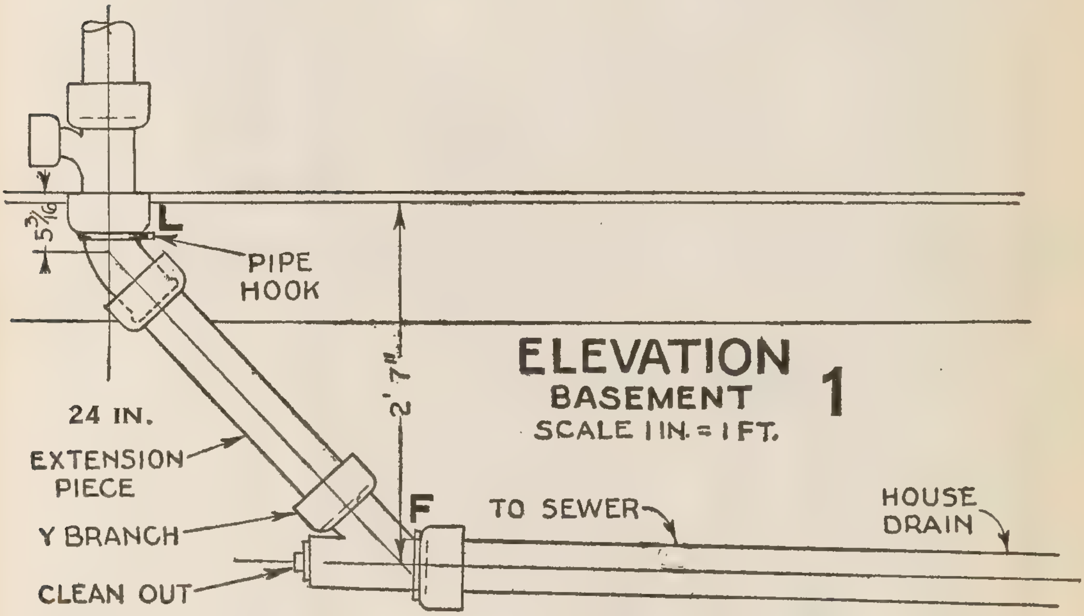


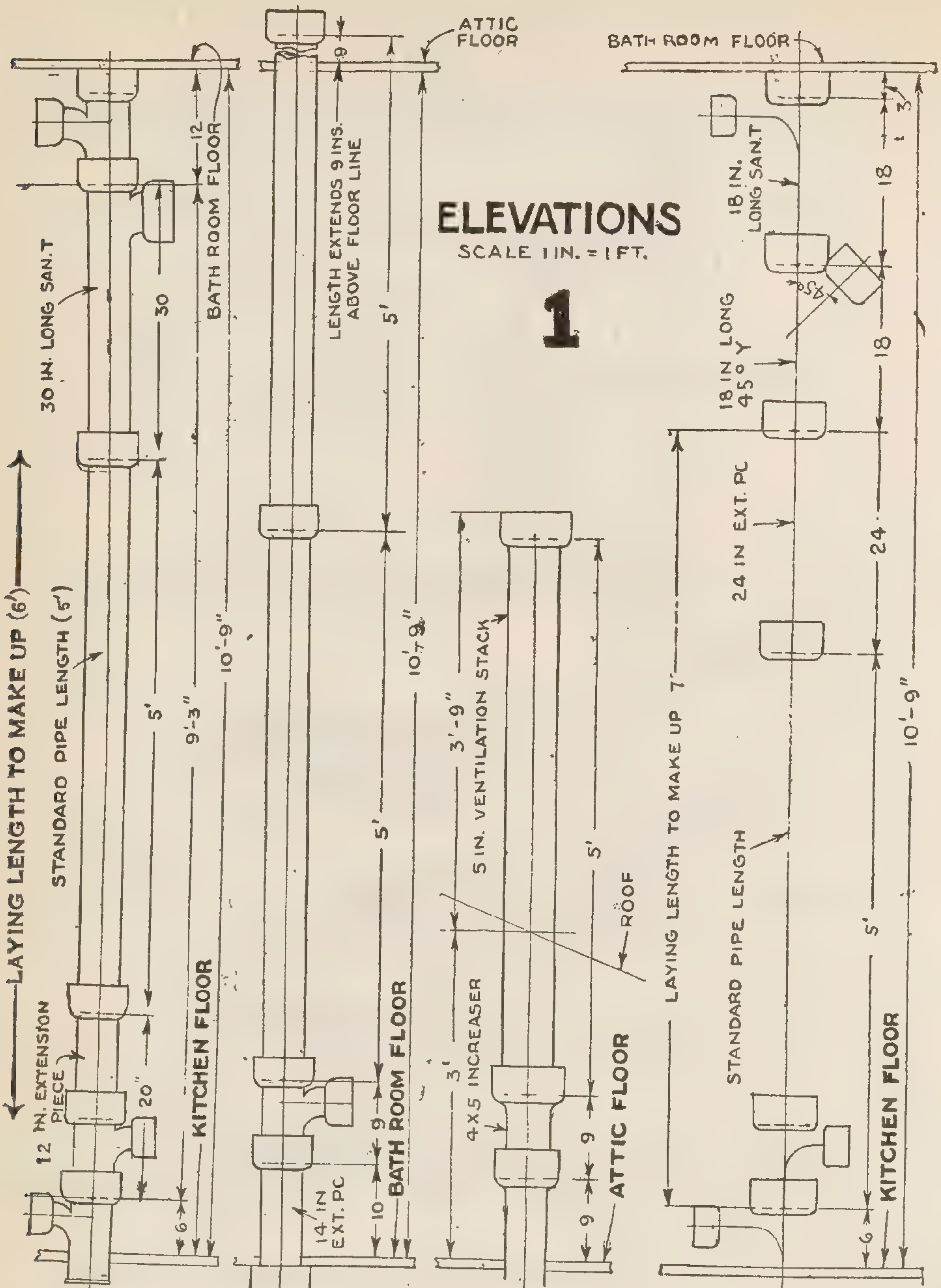
FIG. 6,957.—Elevation of roughing in for basement showing dimensions.

Allowing ½ in. fall (DD′), will permit using a 14 inch extension piece as shown.

By methods similar to those just explained for the bath room, roughing in drawings are made for the kitchen as shown in figs. 6,955 and 6,956.

For the basement, the elevation fig. 6,957, will suffice, no plan being needed.

Never make any unnecessary drawings; the basement illustrates this, as making a *plan* would be a waste of time.



FIGS. 6,958 to 6,960.—Elevations of roughing in for stack.

FIG. 6,961.—Elevation of portion of stack between kitchen and bath room floors illustrating the author's fully abbreviated system of drawing. Compare this figure with fig. 6,958. It is a development of the method shown in fig. 6,950 and will save considerable time.

In this connection note whether a *plan* or *elevation* should be made to give all the necessary dimensions.

Evidently from fig. 6,957, if a plan had been made instead of the elevation, the length of the extension piece could not have been determined because it would appear in projection so that its true length would not be shown.

In fig. 6,957 note the pipe hook supports L and F. The weight of the pipes which is considerable should be properly supported by these devices.

In fig. 6,957, the elevation of the house drain and resulting length of extension piece will depend on the elevation of the ground line. The ⅛ bend and Y branch give easy flow of the drainage.

An essential provision is the clean out plug for the Y branch, especially on long lines to sewer.

It remains now to complete the stack, and since, using the same scale of 1″=1′, would make the drawing too long, it is best shown by separate drawings for each floor as in figs. 6,958 to 6,960.

In drawing the first section of the stack (from basement to bath room) first draw kitchen and bath room floors at the correct vertical distance apart and vertical axis of stack.

Next draw the sanitary Ts serving laundry tubs, sink and bath.

Now by measurement distance between spigot of long sanitary T and end of sink T is 6 ft.

Evidently only one standard 5′ length of pipe can be used in making up this section of the stack. Subtract this from total length thus:

Laying length of make up............	6 ft.
One 5′ length of pipe................	5 "
Balance to make up.................	1 "

This can be made up by use of a 12 in. extension piece as shown in fig. 6,966, or preferably if a 6 ft. length of pipe be available, it can be used for the entire make up thus avoiding the extension piece with its extra joint.

In case some other length of long sanitary T be used, it will be seen by inspection of the following table, that various combinations of long sanitary T and extension piece, of different lengths are available for make up.

Long Sanitary T's and Extension Pieces

	Length in inches										
Long sanitary T....	18	24	30	36							
Extension piece.....	4	6	8	10	12	14	16	18	20	22	24

Continue the stack, through bath room with two pipe lengths, which will bring the stack 9 ins. above bath room ceiling as shown in fig. 6,959.

To complete the stack, add a 4×5 increaser and a length of 5 in. pipe which will bring the end of stack well above the roof.

From the drawings just made the amount of soil pipe and soil pipe fittings required is as follows:

Soil Pipe and Soil Pipe Fittings

	Soil pipe B & S	45° elbow	Y bend	San. T	Extens. piece	Closet ext.	Long San. T	increasers
Basement.	1—4″	1	1		1—24″			
Kitchen.	1—4″			3	1—12″	1—4×16;	1—4×30	
Bath room.	2—4″			1	1—14″			
Attic.	1—5″							1—4×5

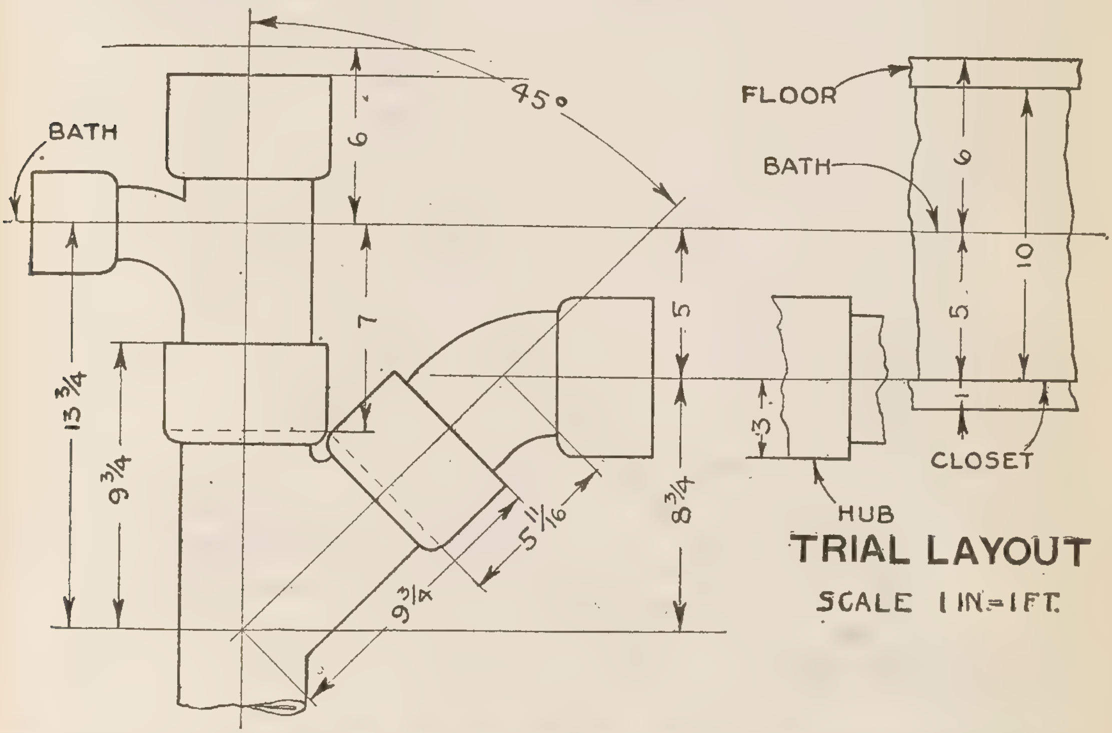
Collecting these items into the form of an order would be as follows:

Soil pipe

4 lengths 4″ B & S pipe.
1 length 5″ B & S pipe.

Fittings

1—4″ 45° elbow.



FIGS. 6,962 and 6,963.—Skeleton trial layout for make up of the close connected closet connection shown in fig. 6,965, using ⅛ bend, and detail showing trial distance of closet connection center line below bath room floor.

1—4″ Y bend.
4—4″ San. T.
1—4×30 long san. T.
3—Extension pieces; 4×12; 4×14; 4×24.
1—4×30 closet connection.
1—4×5 increaser.

In addition there will be needed ferrules, solder unions, traps, wrought and lead pipe, etc., as shown in the drawings.

In place of the lead pipe connection to closet which necessitates the closet connection being placed below the kitchen ceiling, close nipple connection

can be made as shown in fig. 6,965. Here the waste pipe can be concealed between the floor and ceiling with exception of the 45° connection to stack.

Pipe fitters have experienced much difficulty in finding the length of 45° lines. There is no mystery about it; the length of the 45° line may be laid down and measured or calculated either by geometry or trigonometry.

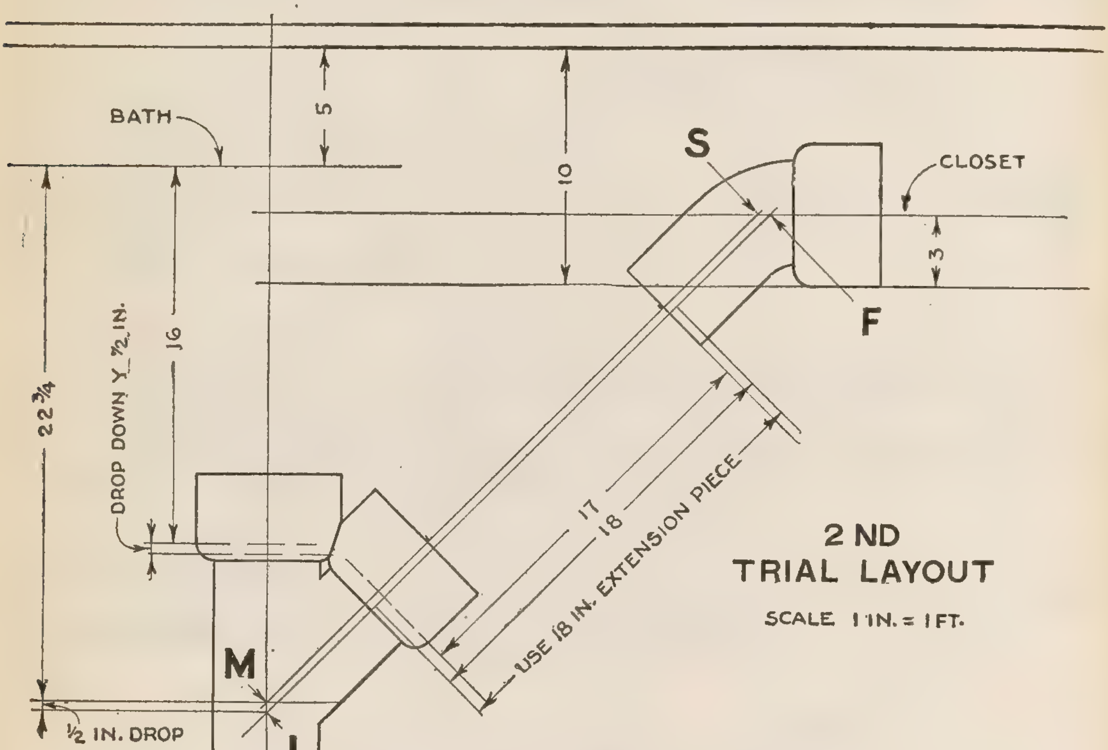


FIG. 6,964.—Skeleton center line layout with close connected closet connected located between the floor and ceiling, showing method of locating the ⅛ or 45° bend and Y, as explained in the text. M,S, trial 45° center line; L,F, corrected 45° center line to permit use of an extension piece, thus avoiding the necessity of cutting a pipe length.

In the graphical method make a skeleton trial layout for a 45° Y and ⅛ bend as in fig. 6,962. The layout shows that with the ⅛ bend connected with the Y branch, the center line of closet connection comes 5 ins. below bath waste center line. Transferring these center lines to fig. 6,963 it is seen that the closet waste center line comes in line with the elevation of lower edge of the beam, thus part of the pipe would project through the ceiling as indicated by the hub detail sketched in at the left. This will not do, hence make another trial layout as in fig. 6,964 placing closet connection between ceiling and floor.

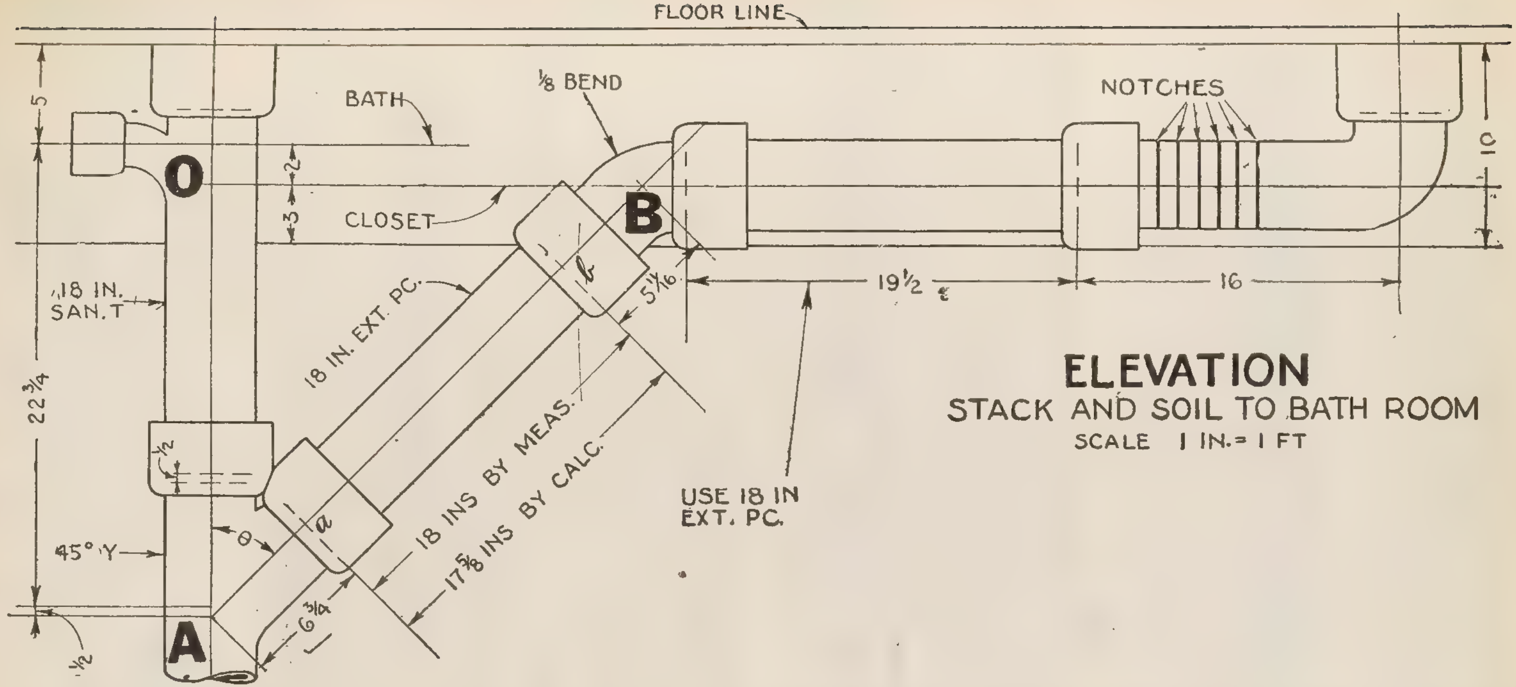


FIG. 6,965.—Elevation of roughing in for bath room using close connected closet connection (instead of the connection with lead sleeve shown in fig. 6,947) corresponding to the center line layout of fig. 6,964.

First draw in closet connection center line at desired elevation, and bath waste and stack center lines. From this line lay out an 18 in. long sanitary T. Connecting with a Y, locating point M, (where the 45° center line intersects the vertical center line) from dimensions on fig. 6,961.

Draw MS, and sketch in the branch hub and ⅛ bend. This gives a measured distance between spigot end and bottom of hub of 17 ins. being 1 in. too short for a 18 in. extension piece. To overcome this, drop the Y down ½ in. which moves the 45° center line from position MS, to position LF, which increases the distance between spigot and hub to 18 ins. by measurement permitting the use of an 18 in. extension piece. The complete layout for this arrangement is shown in fig. 6,965. Here the

distance between $\frac{1}{8}$ bend and closet connection is $19\frac{1}{2}$ ins. If possible, locate closet $\frac{1}{2}$ in. nearer wall to permit use of 20 in. extension piece. If this cannot be done, shorten closet connection by cutting or cut pipe to right length to make up.

By aid of trigonometry and geometry, the length of the 45° line and offset can be calculated, the calculation being very simple as follows:

In fig. 6,965

$$\frac{OB}{OA} = \tan\theta$$

from which

$$OB = OA \tan\theta \quad \text{.............................} (1)$$

Now OA = distance between bath T, center line and point A, plus $\frac{1}{2}$ in., less distance between bath and closet waste center lines $= (22\frac{3}{4} + \frac{1}{2}) - 2 = 21\frac{1}{4}$ and from table of *natural* trigonmetrical functions $\tan\theta = \tan 45° = 1$.

Substituting these values in equation (1).

$$OB = 21\tfrac{1}{4} \times 1 = 21\tfrac{1}{4}$$

By geometry

$$AB^2 = OA^2 + OB^2$$

$$AB = \sqrt{OA^2 + OB^2} \quad \text{.............................} (2)$$

Substituting values for OA and OB in equation (2).

$$AB = \sqrt{(21\tfrac{1}{4})^2 + (21\tfrac{1}{4})^2} = \sqrt{451.56 + 451.56} = \sqrt{903.12}$$
$$= 30.05 \text{ or } 30\tfrac{1}{16} \text{ ins. (approx.)}$$

What is wanted here is the laying distance between the Y branch hub and $\frac{1}{8}$ bend spigot; it is obtained thus:

AB =		$30\frac{1}{16}$ ins.
A*a* =	$6\frac{3}{4}$ ins.	
B*b* =	$5\frac{11}{16}$ ins.	
Total deduction	$12\frac{7}{16}$ ins.	$12\frac{7}{16}$ ins.
	Laying length =	$17\frac{5}{8}$ ins.

Comparing results, the laying length is 18 ins. by measurement and 17⅝ by calculation, a difference of ⅜ in.

The calculation should be accepted as correct and the error considered as being due to inaccuracies in the drawing.*

These inaccuracies being caused by the difficulty of laying off and reading measurements on such a small scale. The scale used was 1″ = 1′ and it should be noted that the smallest division on this scale is ¼ in., the 8ths. and 16ths. having to be guessed at "by eye" and it takes pretty good eyesight to read even ¼ in. division on the 1″ = 1′ scale.

Assuming the calculated distance 17⅝ to be correct, theoretically an 18 in. extension piece cannot be used, but practically it can, as in such rough work as installing soil pipe it is not necessary to work with such precision and the difference can be shifted a little to allow for the ⅜ in. necessary for the 18 in. extension piece, and this should be done because, as before stated extension pieces are much more desirable than using a cut piece of double hub pipe.

The arrangement shown in fig. 6,965 will require a different stack layout between kitchen and bath room because the spigot end of the Y comes at a different elevation than the spigot end of the long sanitary T, which gives a different stack laying length to make up in the kitchen.

Fig. 6,961, shows layout for stack using the Y arrangement. It illustrates besides the author's abbreviated system of drawing (which compare

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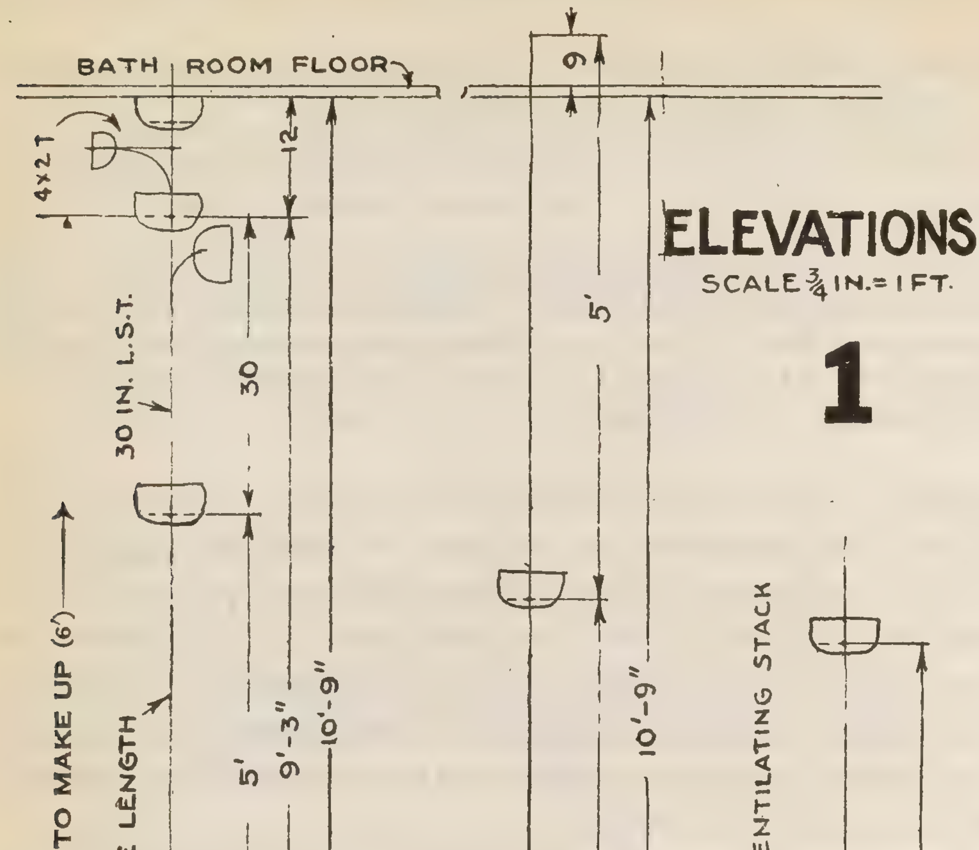
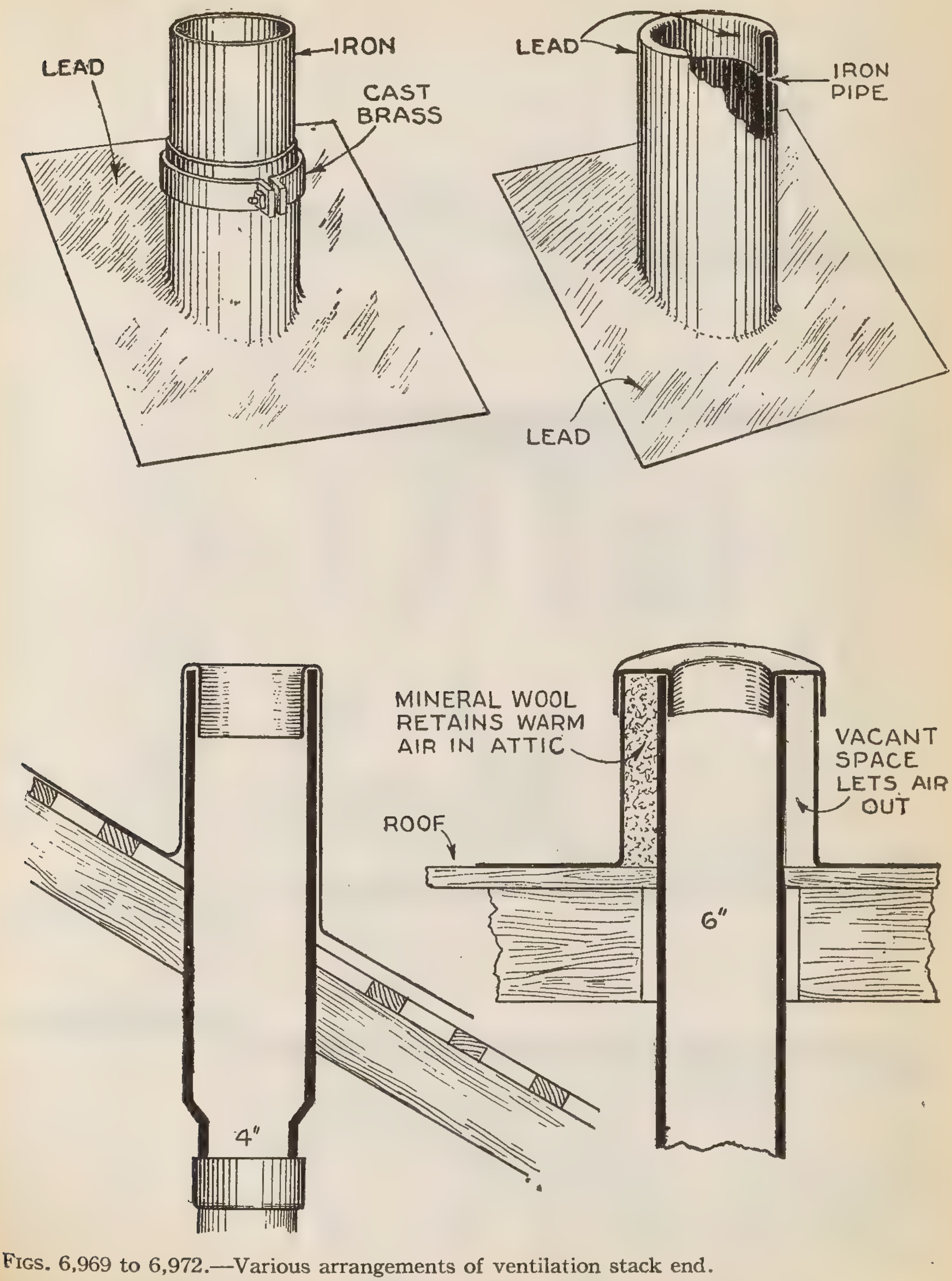
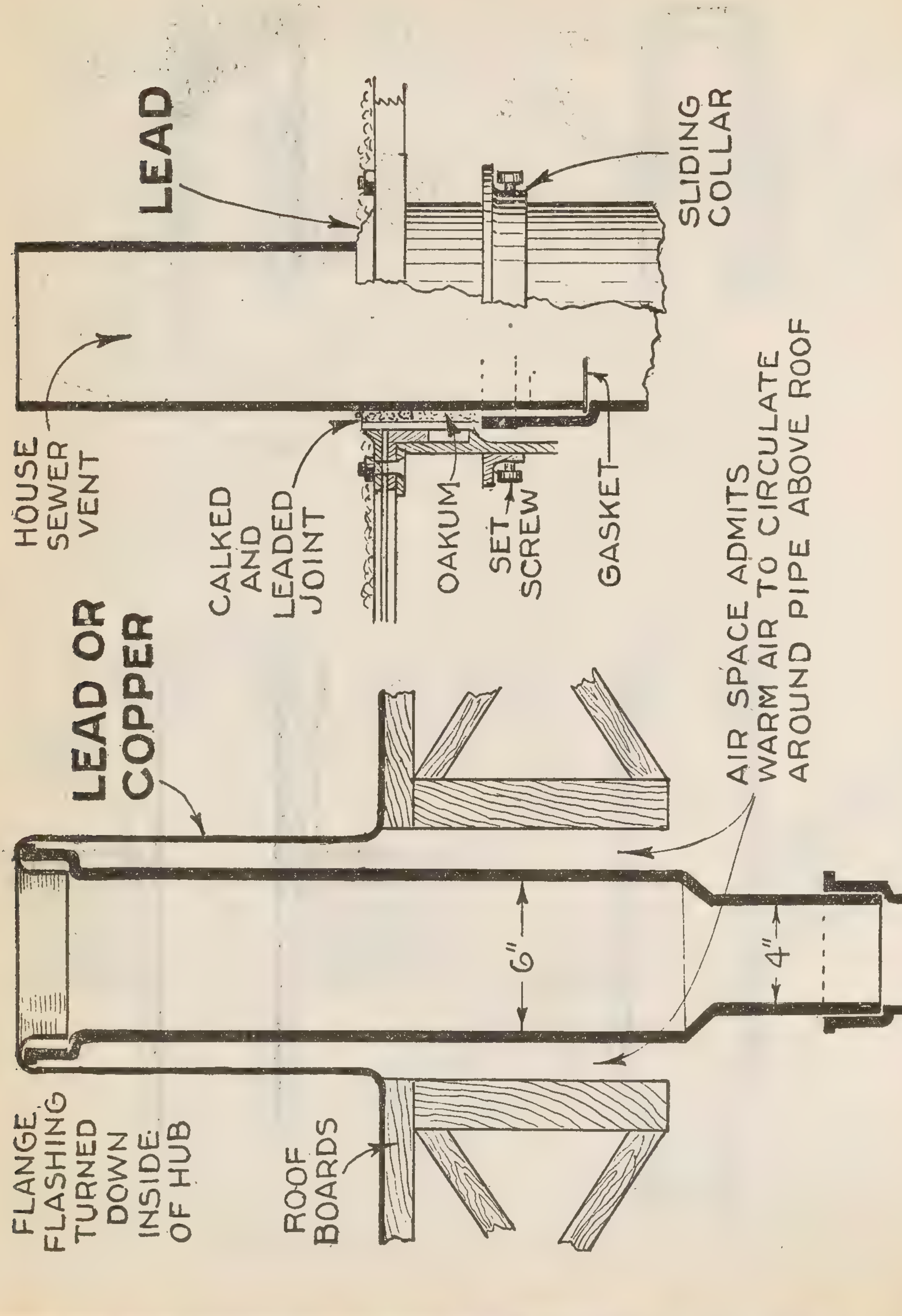
*NOTE.—***It should be noted** here that a calculation gives correct values (assuming the data upon which the calculation is based be correct) whereas any drawing is simply an approximation; thus we say: ***describe a circle*** instead of ***draw a circle***, because no matter how carefully and skilfully the draughtsman may work, he could not produce an absolutely true circle. Examined under a microscope the circle would be found to be full of irregularities, variations in curvature, due to springing of the compass, roughness of the paper, uneven flow of ink, stress of center point on the paper, etc.



FIGS. 6,966 to 6,968.—Representation of the stack shown in figs. 6,958 to 6,961, by the author's fully abbreviated system of drawing soil fittings as explained in figs. 6,983 to 6,985. The system is partly graphic and partly descriptive. For instance, the pipe between fittings is not drawn in but simply specified.



Figs. 6,969 to 6,972.—Various arrangements of ventilation stack end.



FIGS. 6,973 and 6,974.—Construction details for ventilation stack end.

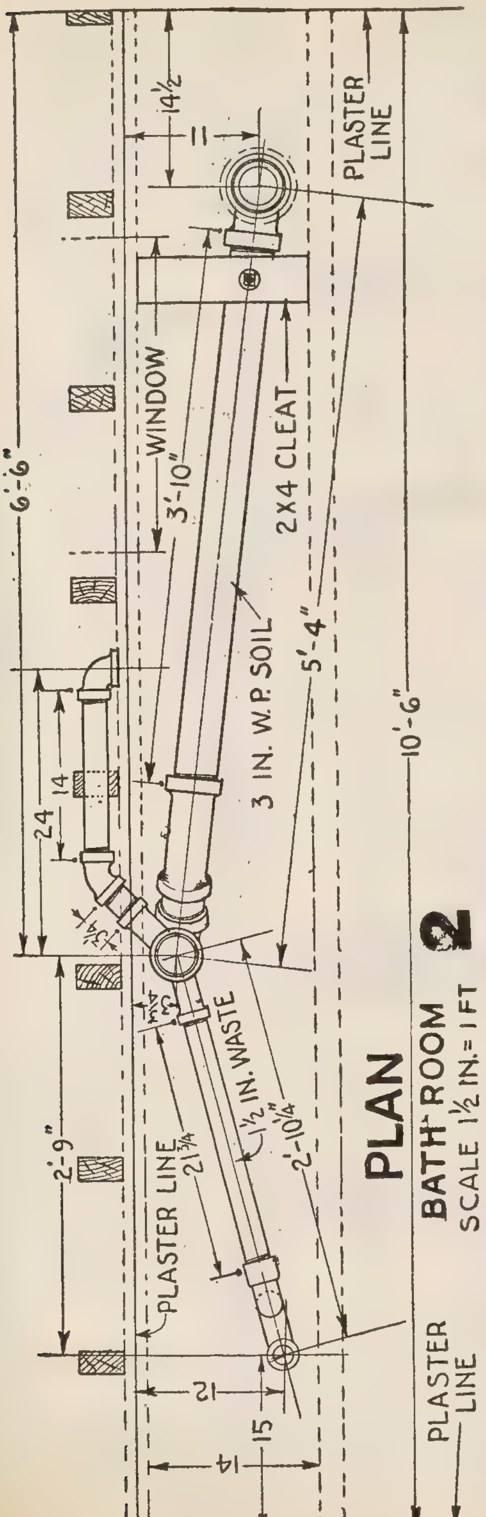


Fig. 6,975.—Plan of roughing in for bath room showing dimensions with wrought pipe and recessed screwed fittings, called drainage fittings and also known as the Durham system.

with fig. 6,958) and also the use of a 24 in. extension piece necessary to make up the odd length.

In fig. 6,961, no allowance is made for the half inch drop shown in figs. 6,964 and 6,965. Disregard the half inch so as to make up the stack with a 24 extension piece. In making up the hanch to closet the 18 in. extension piece and ⅛ bend may swing a little out of the true 45° position, cutting the closet connection to right length to bring the inlet in proper position.

Lay Out with Wrought Pipe and Recessed Screwed Fittings.—The fittings used in this system (known as the Durham System) are the same as the fittings used for water or steam with the exception that they are made with a shoulder so that they are of the same inside diameter as the pipe; thus, at the joint, the inside surface of the fittings comes flush with the inside surface of the pipe so that there is no projecting part to catch particles of matter and clog the passage.

NOTE.—***Soil pipe insert*** is virtually an adjustable extension piece permitting considerable variation of length without altering the depth of the socket. It makes a perfect joint, whereas the practice of gaining length by reducing the telescoping at the expense of reducing the packing depth is open to criticism, especially in view of the temptation to overdo it.

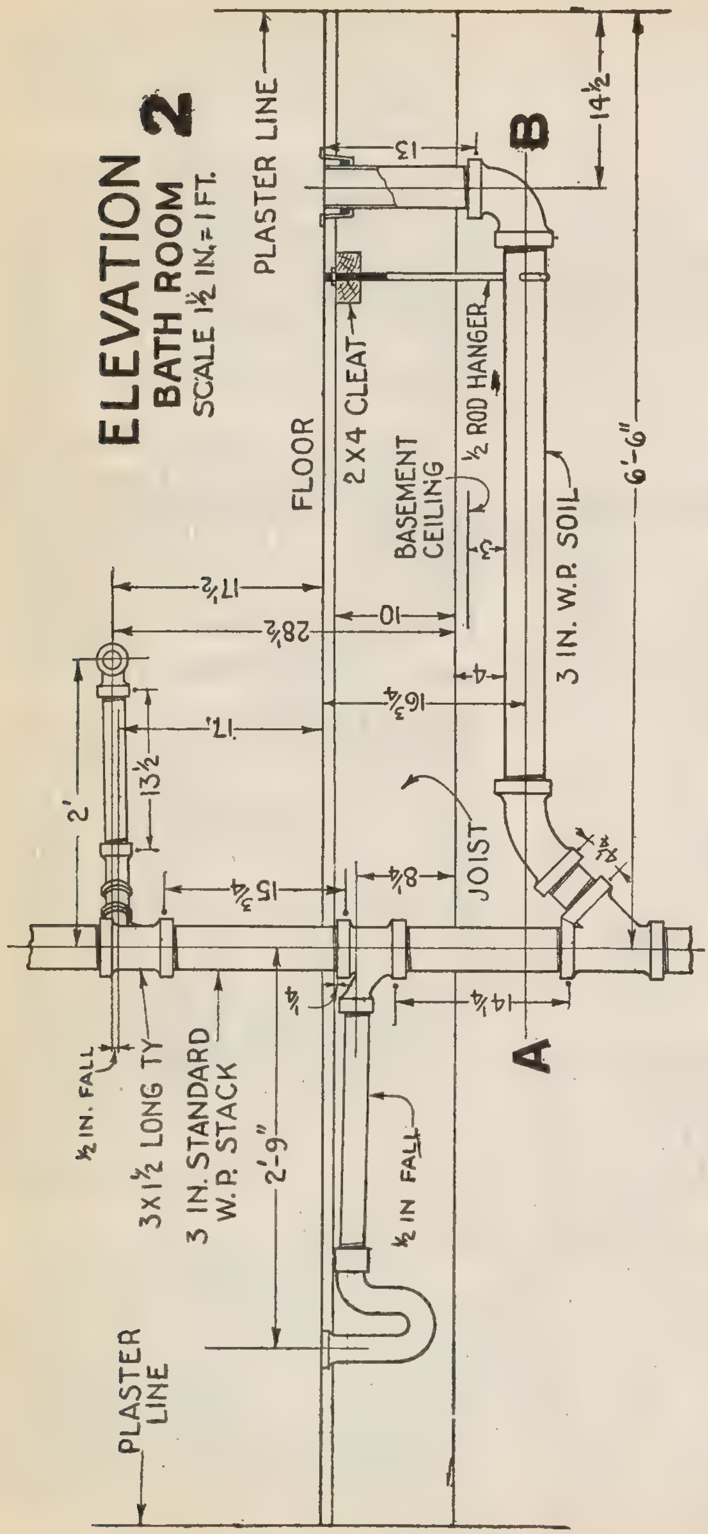


Fig. 6,976.—Elevation of roughing in for bath room showing dimensions with wrought pipe and recessed screwed fittings.

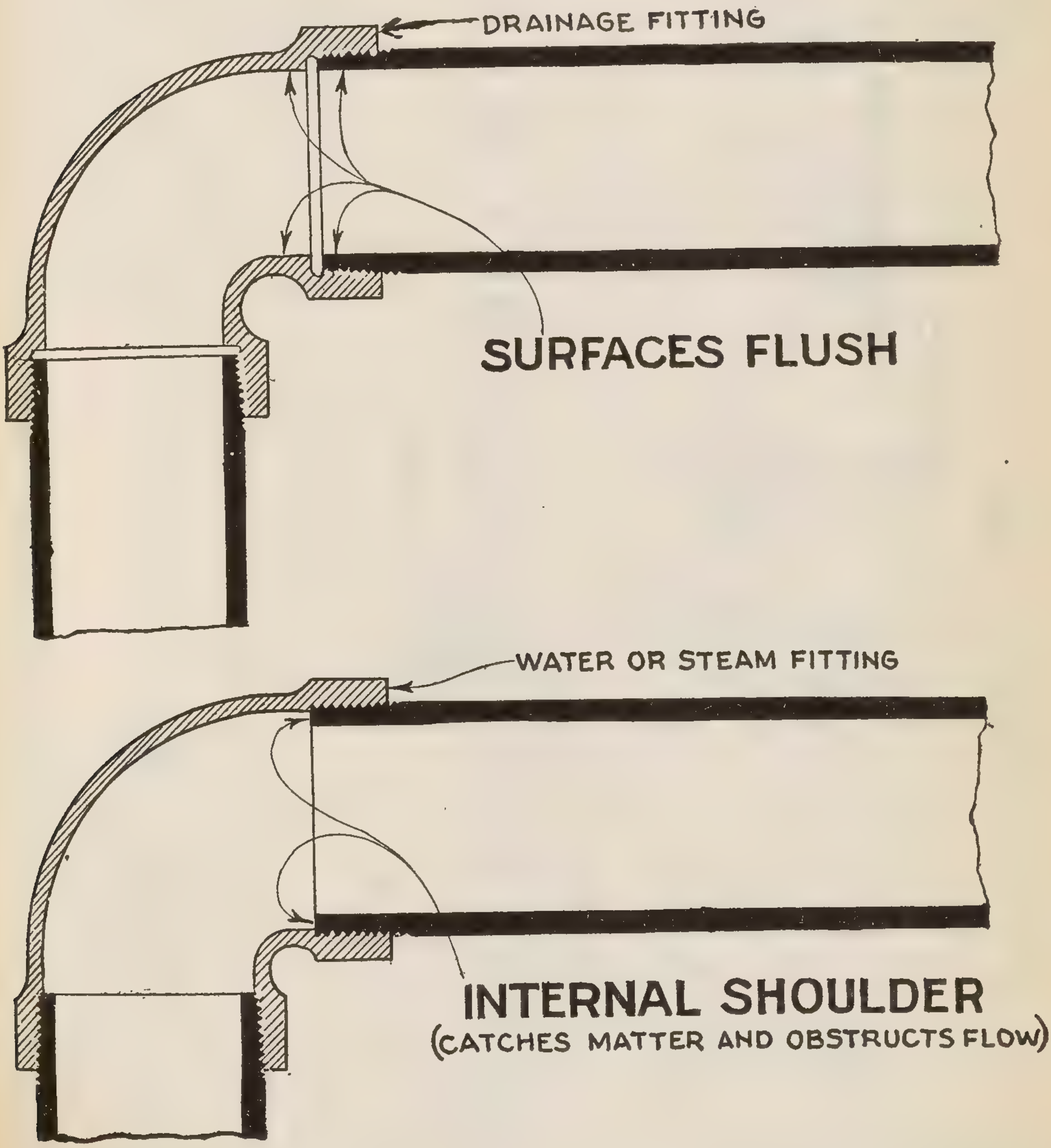
The difference between these fittings and ordinary steam fittings is shown in figs. 6,977 and 6,978.

It should be carefully noted that these fittings are known as *drainage fittings* as distinguished from soil pipe fittings or fittings with bell and spigot ends for caulked joints. The threads on drainage fittings are the same as on water or steam fittings. They are made either in malleable or in cast iron and can be had galvanized. The malleable fittings are made from the cast iron patterns. When not otherwise specified drainage fittings are coated with heated asphaltum excepting those for use in New York City which are not coated.

On vent lines ordinary water or steam fittings may be used.

Even with the flush surfaces obtained with drainage fittings more trouble is experienced from the lodgment of solid matter with these fittings than with soil pipe fittings and for this reason special care should be taken in cutting the wrought pipe to remove all burrs by reaming.

All drainage fittings should be galvanized.



FIGS. 6,977 and 6,978.—Comparison of ordinary and recessed screwed or drainage fittings showing reason why ordinary screwed fittings are unsuitable for drainage lines.

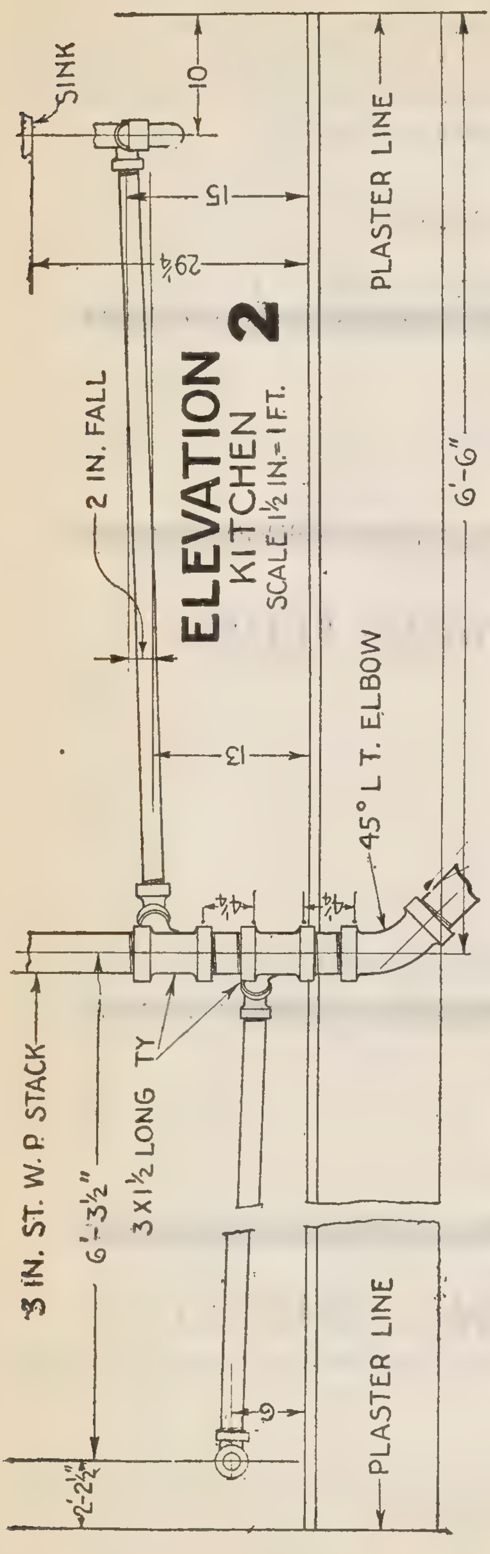


FIG. 6,979.—Elevation of roughing in for kitchen showing dimensions with wrought pipe and recessed screwed fittings.

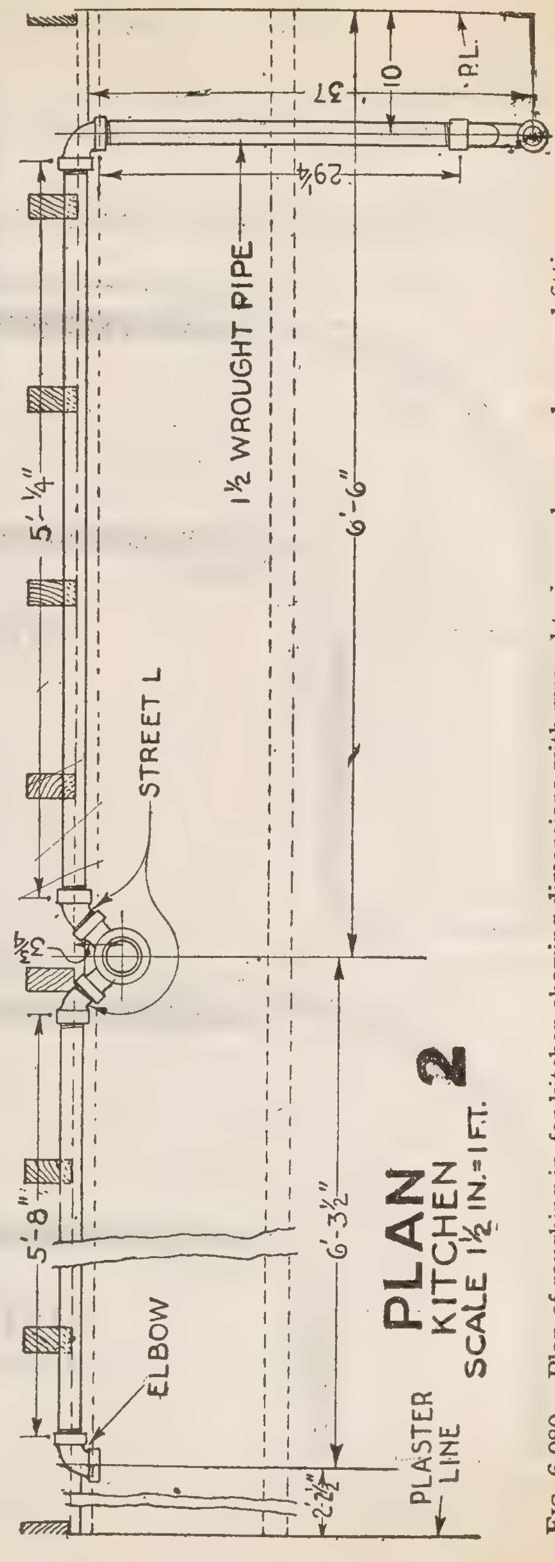


FIG. 6,980.—Plan of roughing in for kitchen showing dimensions with wrought pipe and recessed screwed fittings.

About the only advantage of the Durham system is the reduction in weight, which in high buildings results in considerably less weight to be supported. Figs. 6,975 to 6,988 show the same installation (fig. 6,942) as has been described for soil pipe, worked out for the Durham system.

Roughing In with Soil and Vent Stacks or Loop.—In the installation just described both for soil fittings and for drainage fittings only a single stack was used, the idea being to present the simplest and cheapest installation. In order to show

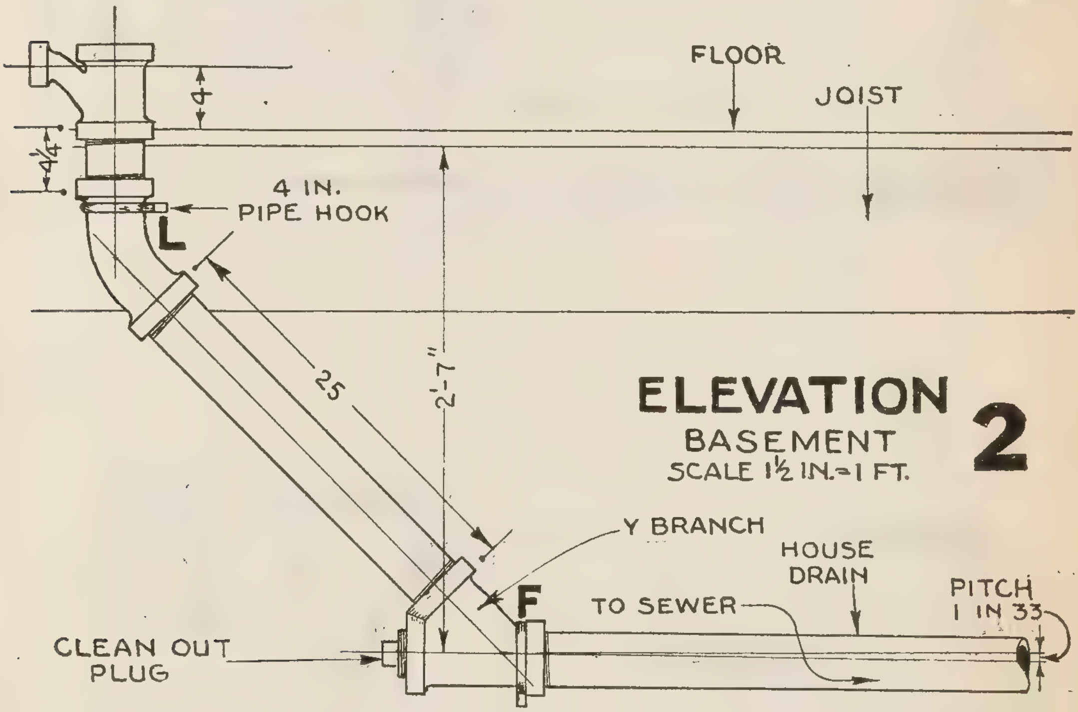


Fig. 6,981.—Elevation of roughing in for basement showing dimensions with wrought pipe and recessed screwed fittings.

the method of roughing in where full provision is made for ventilation, the arrangement of drainage piping for the same fixtures is presented in the accompanying series of drawings.

First make entirely in free hand a sketch similar to fig. 6,942, showing in elevation location of all the fixtures; do not take measurements but approximate the location of fixtures "by eye."

The general arrangement of the piping should now be shown

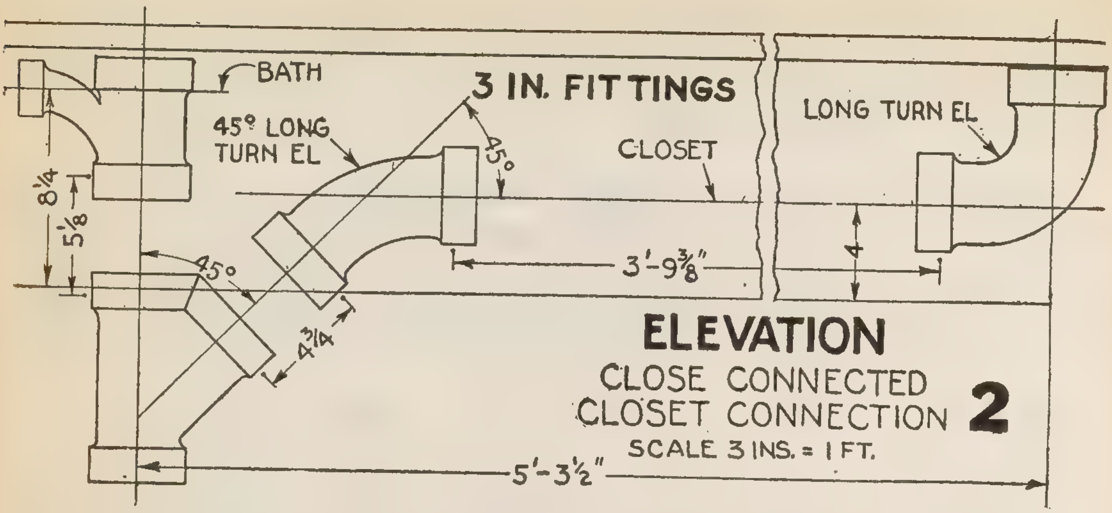
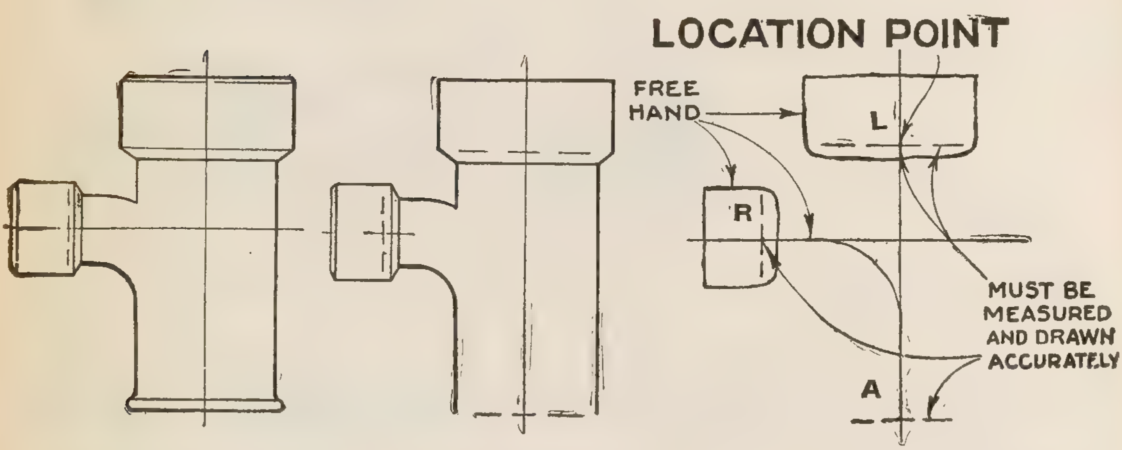
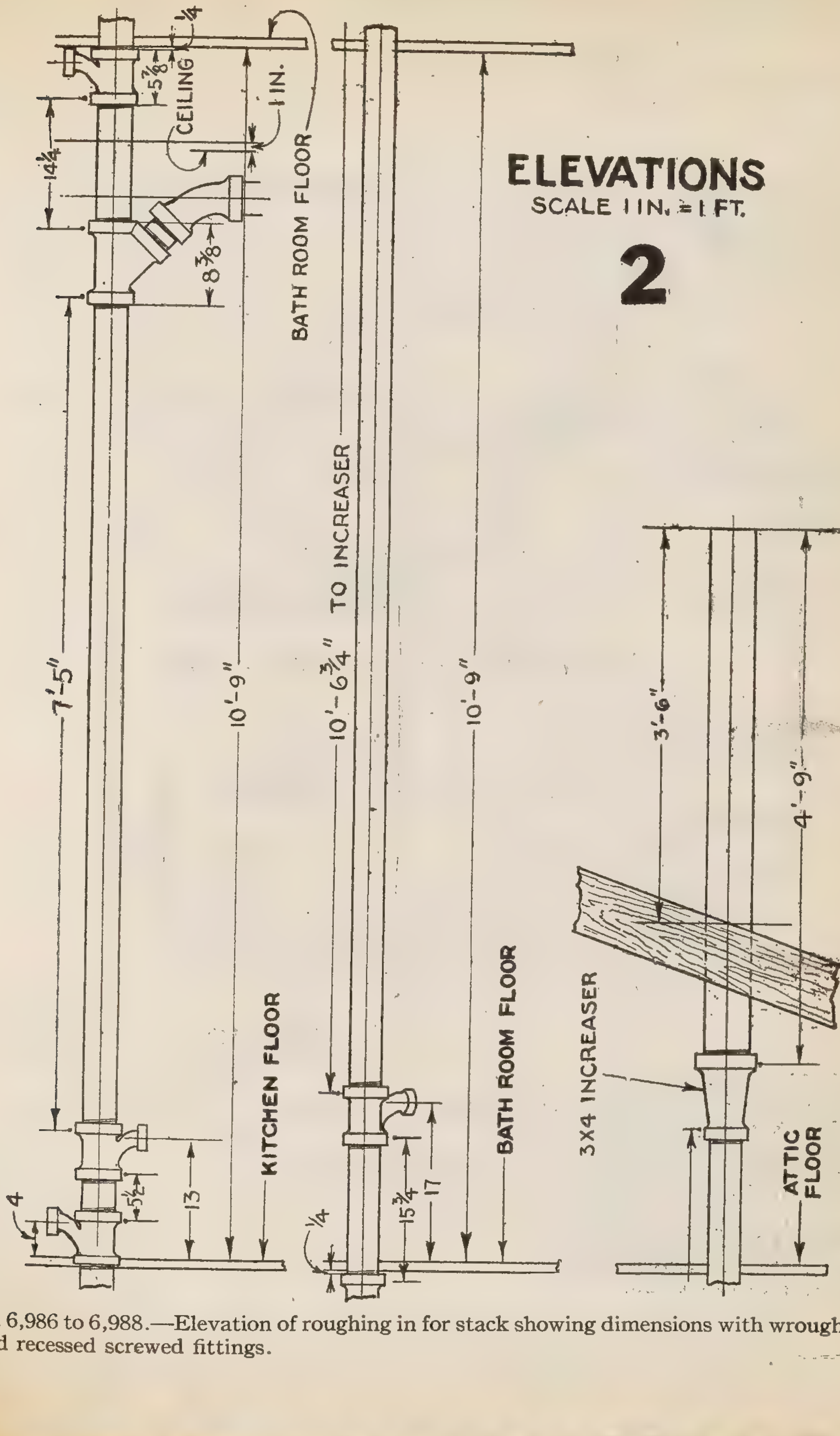


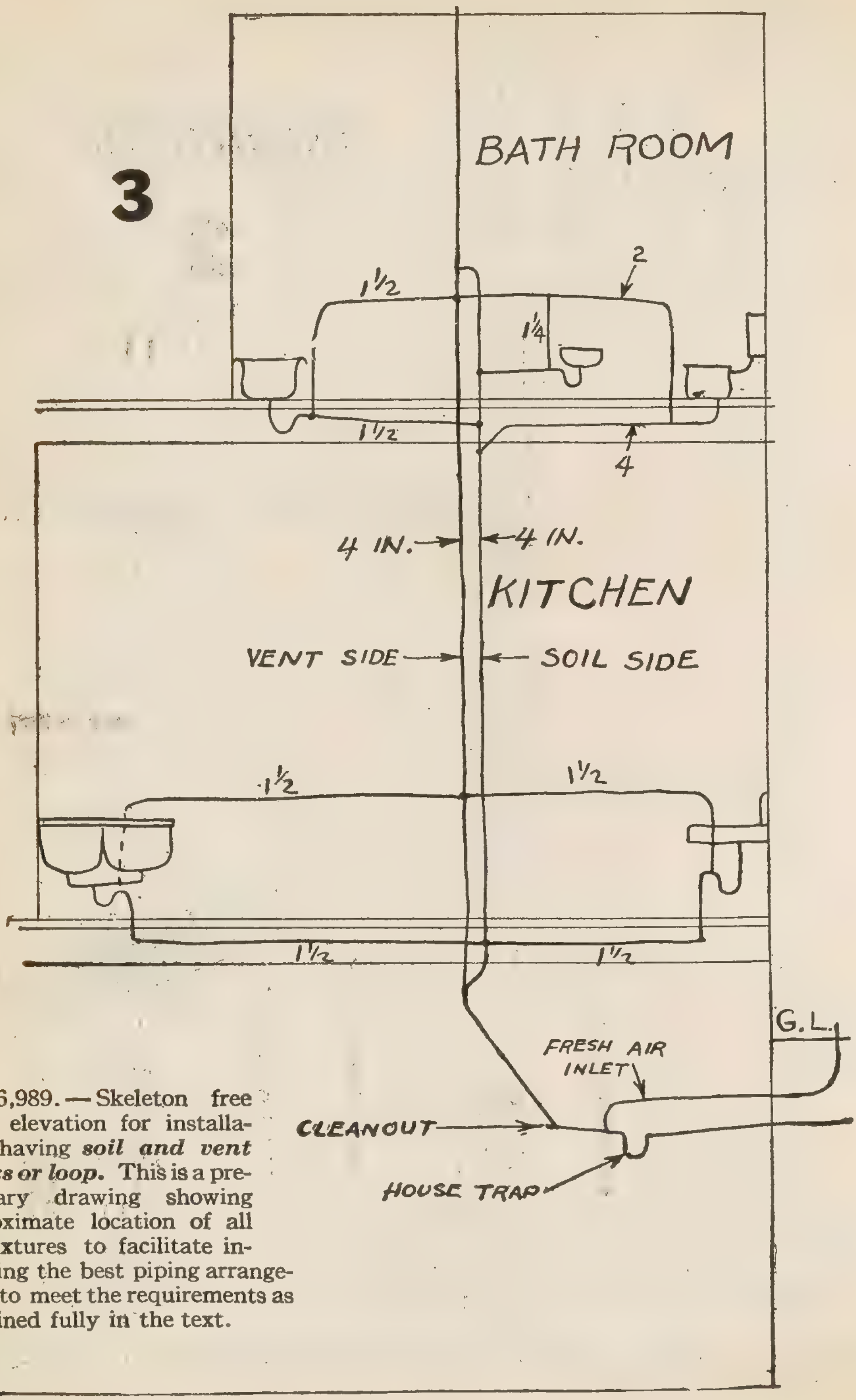
FIG. 6,982.—Skeleton center line layout with close connected closet connection giving dimensions with wrought pipe and recessed screwed fittings.



FIGS. 6,983 to 6,985.—Representation of a soil fitting in full detail, and by the author's semi-, and fully abbreviated system showing the important dotted lines representing bottom of sockets and end of spigot which must be located and drawn with precision, and the unimportant parts which may be drawn free hand. These unimportant parts are only put in to indicate the fitting otherwise they could be omitted. In drawing the dotted lines make only three dashes, one of which intersects the axis through the location point. It is upon the proper laying out of the location points L,A,R, that the accuracy of the drawing depends and they should not be marked with a pencil having an acre of lead for a point.



FIGS. 6,986 to 6,988.—Elevation of roughing in for stack showing dimensions with wrought pipe and recessed screwed fittings.

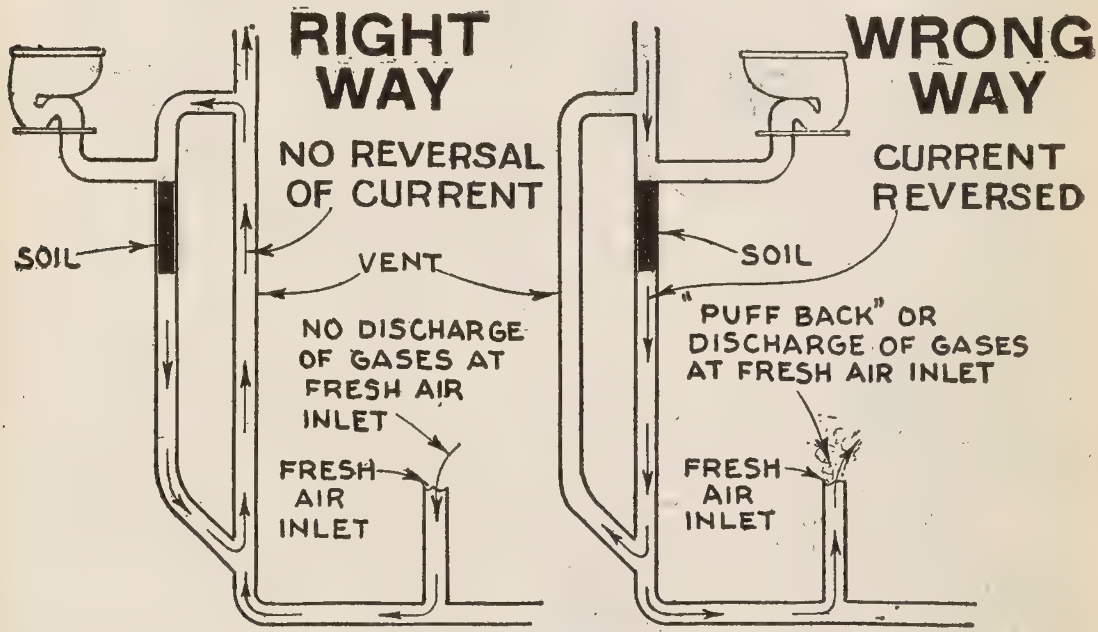


FIGS. 6,989.—Skeleton free hand elevation for installation having ***soil and vent stacks or loop.*** This is a preliminary drawing showing approximate location of all the fixtures to facilitate indicating the best piping arrangement to meet the requirements as explained fully in the text.

on this sketch, representing the pipe simply by lines drawn in free hand as in fig. 6,989.

In determining how the piping should be arranged, the first consideration is which pipe of the loop to use for the soil pipe. This will depend upon whether the best results, or cheapest installation is desired. Here, it should be remembered that the action of the loop causes air to be pushed before the water discharged from a fixture and a partial vacuum to be formed behind the water. This causes a revolution of the air in the loop.

Now the important point is this: *air takes the course offering*



FIGS. 6,990 and 6,991.—***Right*** and ***wrong*** application of a ventilation loop. *Fixtures should drain into the branch or offset leg instead of the main or stack leg;* this prevents a reversal of air current during trap discharge.

the least resistance, hence making both pipes the same size, the greater part of a current of air passing upward through them will travel by the pipe which forms a part of the main stack rather than by the branch pipe which branches out of and into the main pipe.

By taking the branch pipe for the soil pipe, the bulk of the air current which normally is flowing upward is not reversed but only checked; whereas,

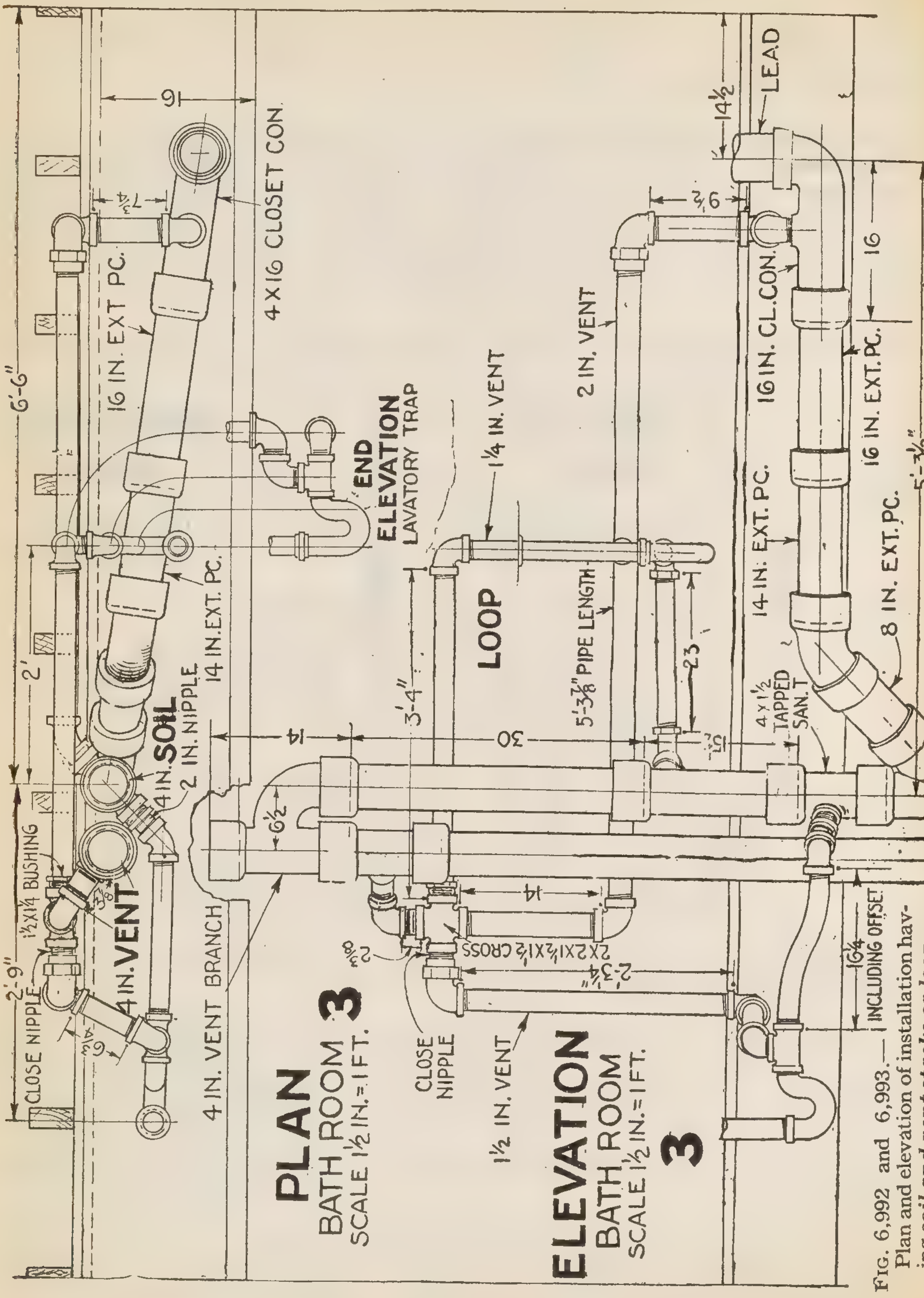
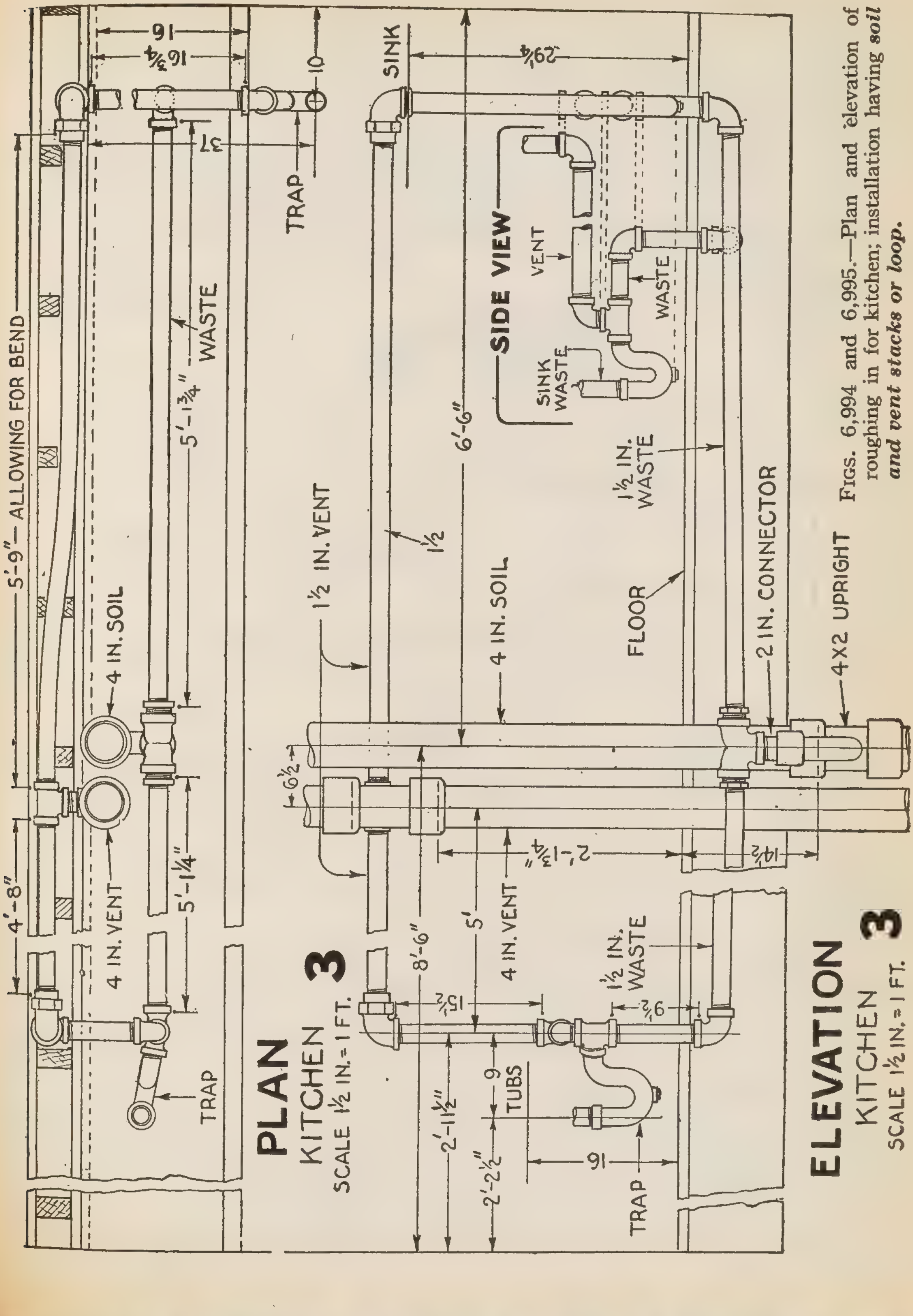


FIG. 6,992 and 6,993.—Plan and elevation of installation having ***soil and vent stacks or loop.***



FIGS. 6,994 and 6,995.—Plan and elevation of roughing in for kitchen; installation having ***soil and vent stacks or loop.***

using main pipe for soil results in reversal of current and puff back at fresh air inlet as shown in fig. 6,991. Moreover whatever offset may be necessary to reach the closet openings will be washed and the straight vertical stack left for the vent affords no chance for the lodgment of rust or other obstructions. Accordingly place the branch pipe of the loop on that side most convenient to receive the discharge from the fixtures. This will be determined principally by the location of the closet and should be placed as in fig. 6,989. Here three of the five fixtures discharge into the branch side of the loop leaving only two waste lines to cross over to the soil side.

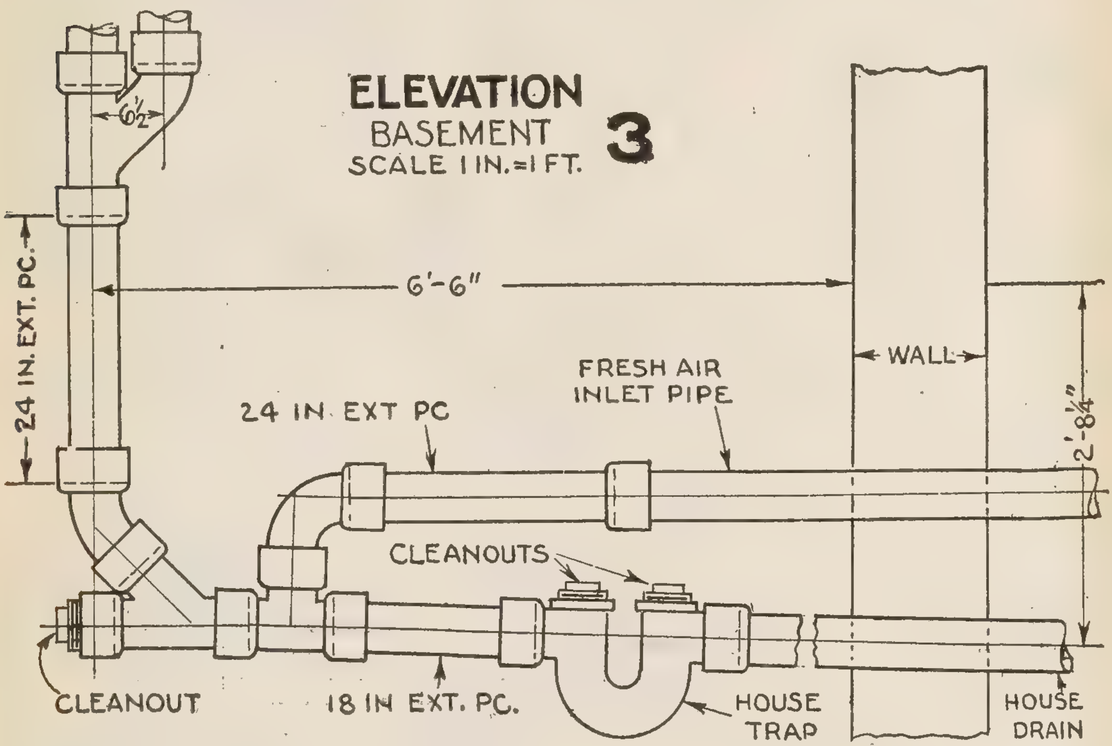


FIG. 6,996.—Elevation of roughing in for basement; installation having ***soil and vent stacks or loop.***

In laying out the vent pipes they should pitch upward from beginning at trap to connection with vent stack.

The point at which a vent line enters stack should be sufficiently higher than the trap which it serves, so that there is no possibility of back flow of water through vent line into vent stack.

Each vent line should have a separate connection with the vent stack, otherwise if two or more vent lines entered stack through a single connection the relieving capacity of these lines would be reduced in case of simultaneous discharge through the traps which they serve.

Of course two or more traps may be served by a single branch vent line

without reducing the venting capacity if the branch vent be progressively increased in size toward the stack so that the area at stack will equal the sum of the areas of the several vent pipes leading to the traps served by the branch vent. The layout in fig. 6,989 with its individual vent lines while giving ideal ventilation, involves too much piping and fittings for economy and simplicity, accordingly from these view points, branch vent lines serving two or more fixtures are used.

As stated the branch vent line should be progressively increased in size toward the stack in proportion to the number of vent pipes along the line as shown in fig. 6,997. The following is the method of proportioning the branch vent.

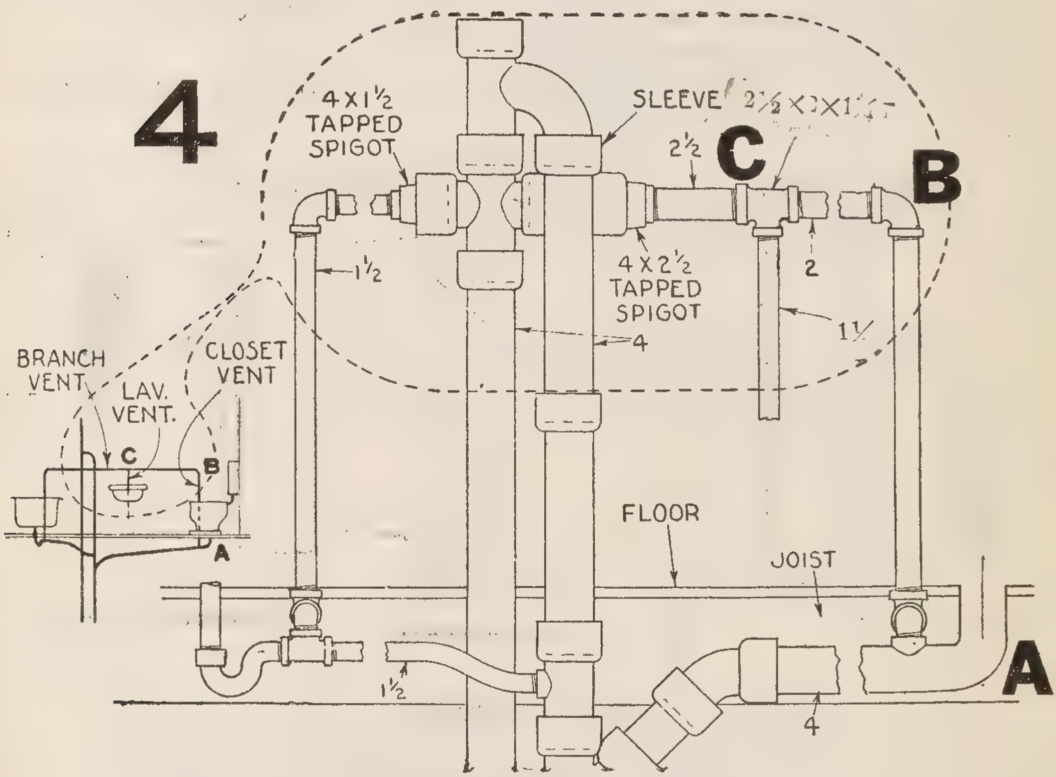


FIG. 6,997.—Elevation of roughing in for bath room; installation having ***soil and vent stacks or loop,*** and provided with "tapered" branch vent pipe instead of vent separately connected to main vent pipe. The enlargement at the right shows in detail the piping of the system indicated in the skeleton sketch.

Starting at the closet at A, the minimum size vent pipe permissible is 2 ins. This 2 in. vent pipe will connect with the branch vent at B, preferably by long turn elbow (to reduce resistance of air flow). The branch vent will be of the same size pipe (2 in.) up to the junction C, where the lavatory vent is connected. Here the branch vent should be enlarged.

The size of vent between C and stack is obtained thus:

Internal transverse area 2 in. closet vent pipe	....	3.355 sq. ins.
" " " 1½ in. lavatory vent pipe	..	2.036 sq. ins.
Total transverse area to be served	....	5.391 sq. ins.

There is no size pipe corresponding to this area, as from table giving "*properties*" of standard wrought pipe (the kind used in this instance).

Internal area 2½ in. pipe = 4.788 sq. ins.
Internal area 3 in. pipe = 7.393 sq. ins.

Thus the 2½ in. pipe is too small and the 3 in. pipe too large and a choice between the two must be made. Accordingly, owing to the fact that it would be very seldom that both traps would discharge at the same time, the smaller or 2½ in. pipe is selected.

The junction at C, where the branch vent is enlarged is made with a reducing T as shown in fig. 6,998.

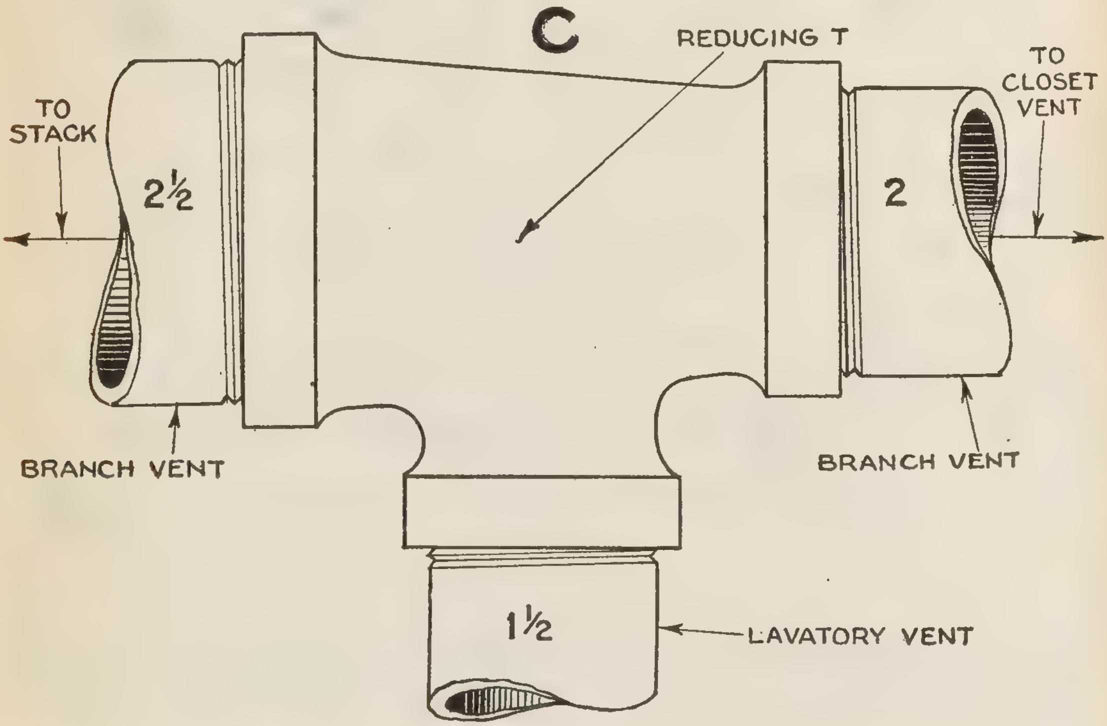


Fig. 6,998.—Method of "tapering" the branch vent by means of reducing T at junction of branch vent pipe with vent pipe.

An unscrupulous contractor trying to increase his profits will run a branch vent the same size to stack regardless of the number of traps served. This extreme or the other extreme of increasing the branch vent to full area in case it serve a multiplicity of traps should not be followed.

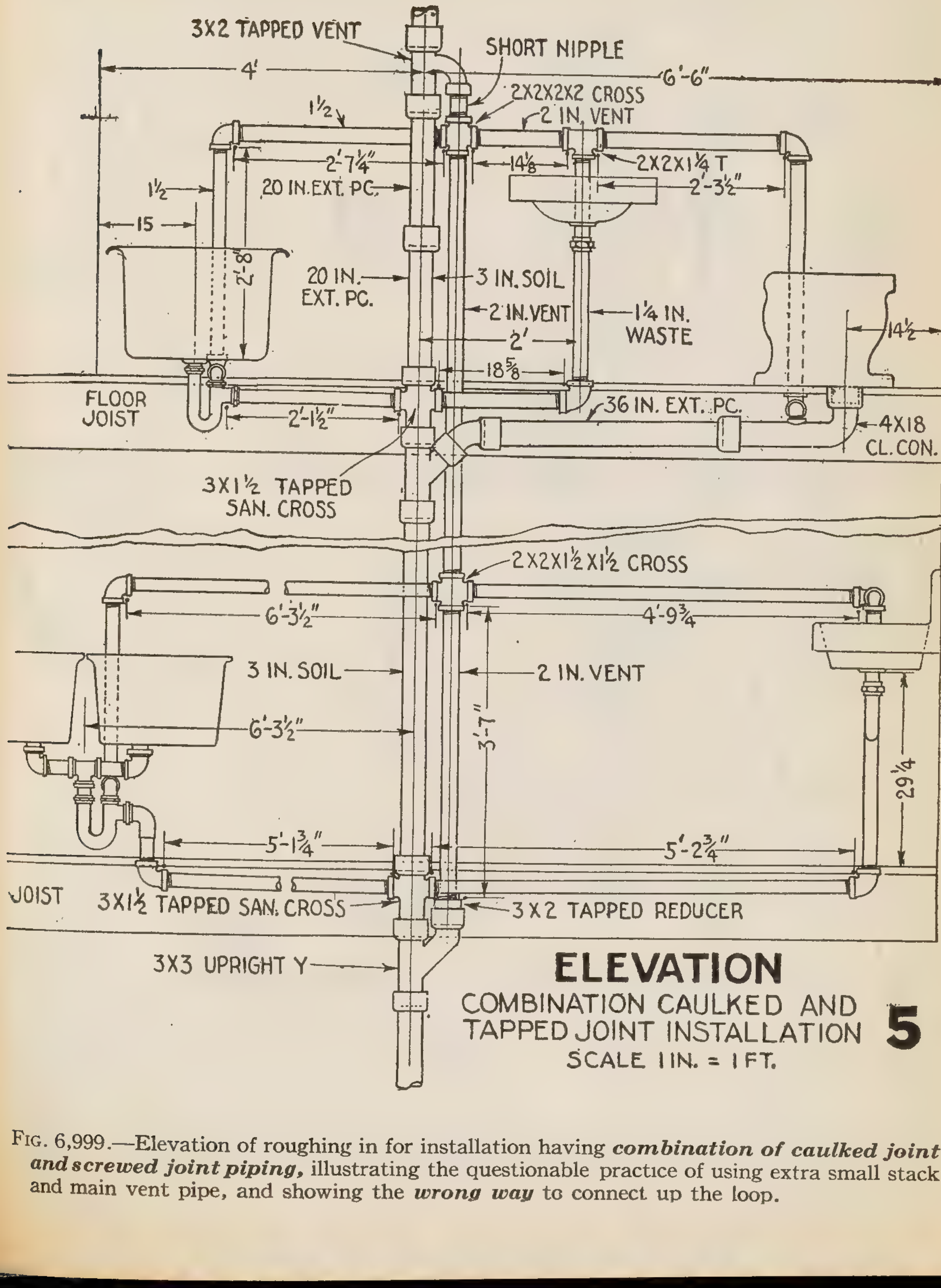


FIG. 6,999.—Elevation of roughing in for installation having ***combination of caulked joint and screwed joint piping,*** illustrating the questionable practice of using extra small stack and main vent pipe, and showing the ***wrong way*** to connect up the loop.

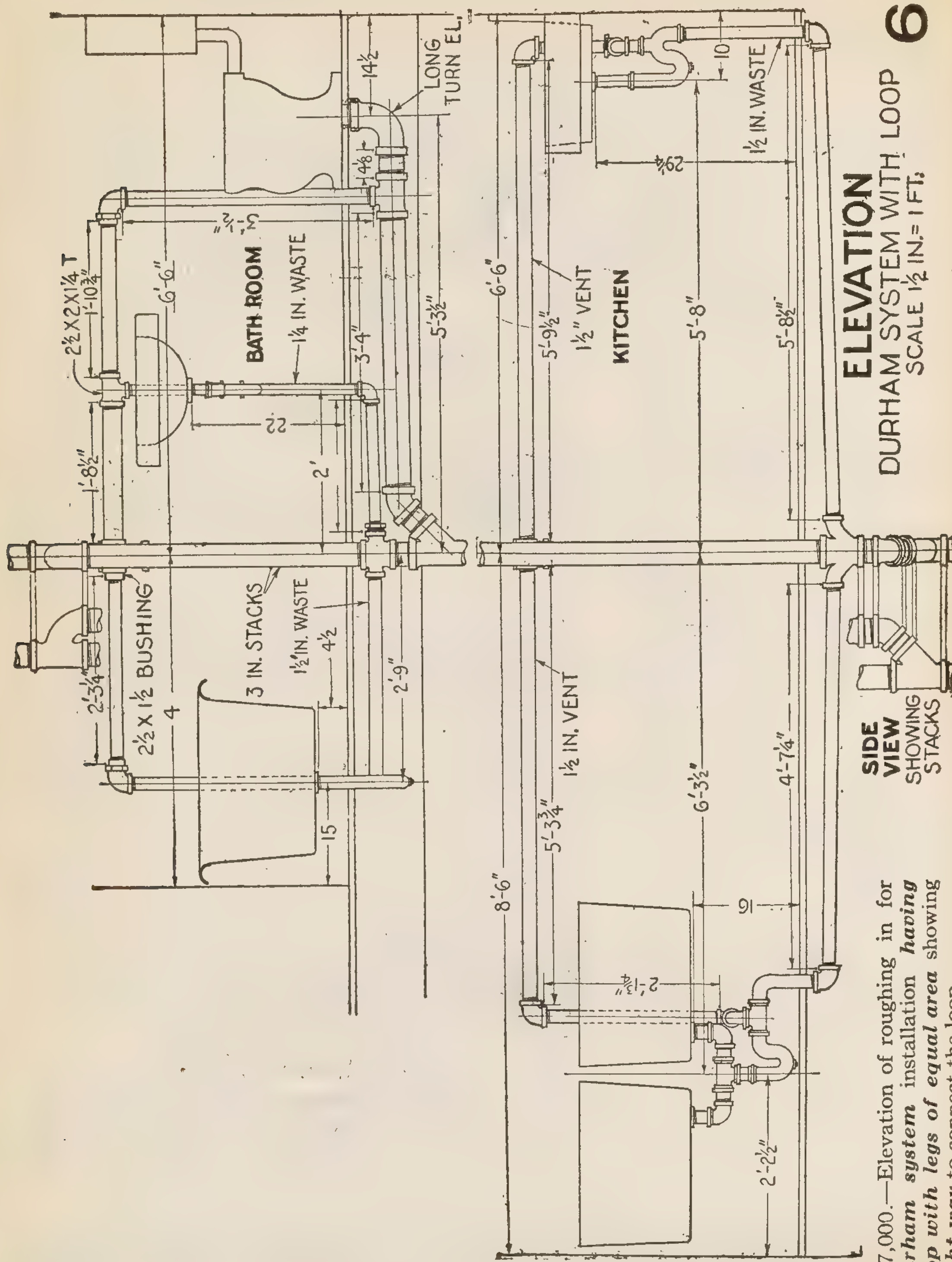


FIG. 7,000.—Elevation of roughing in for ***Durham system*** installation ***having loop with legs of equal area*** showing ***right way*** to connect the loop.

In the latter case it would lead to needless expense. Where there are numerous traps served by one branch vent, the proper method of proportioning the branch vent is to carefully consider the conditions of the particular installation and judge what proportion of the total number of traps on the line are liable to discharge at the same time, and proportion the area of branch vent for this number of traps rather than for all the traps on the line. Thus, in a residence, the proportion of traps to be provided for would, as must be evident, be less than in some public place, as the wash room of a hotel.

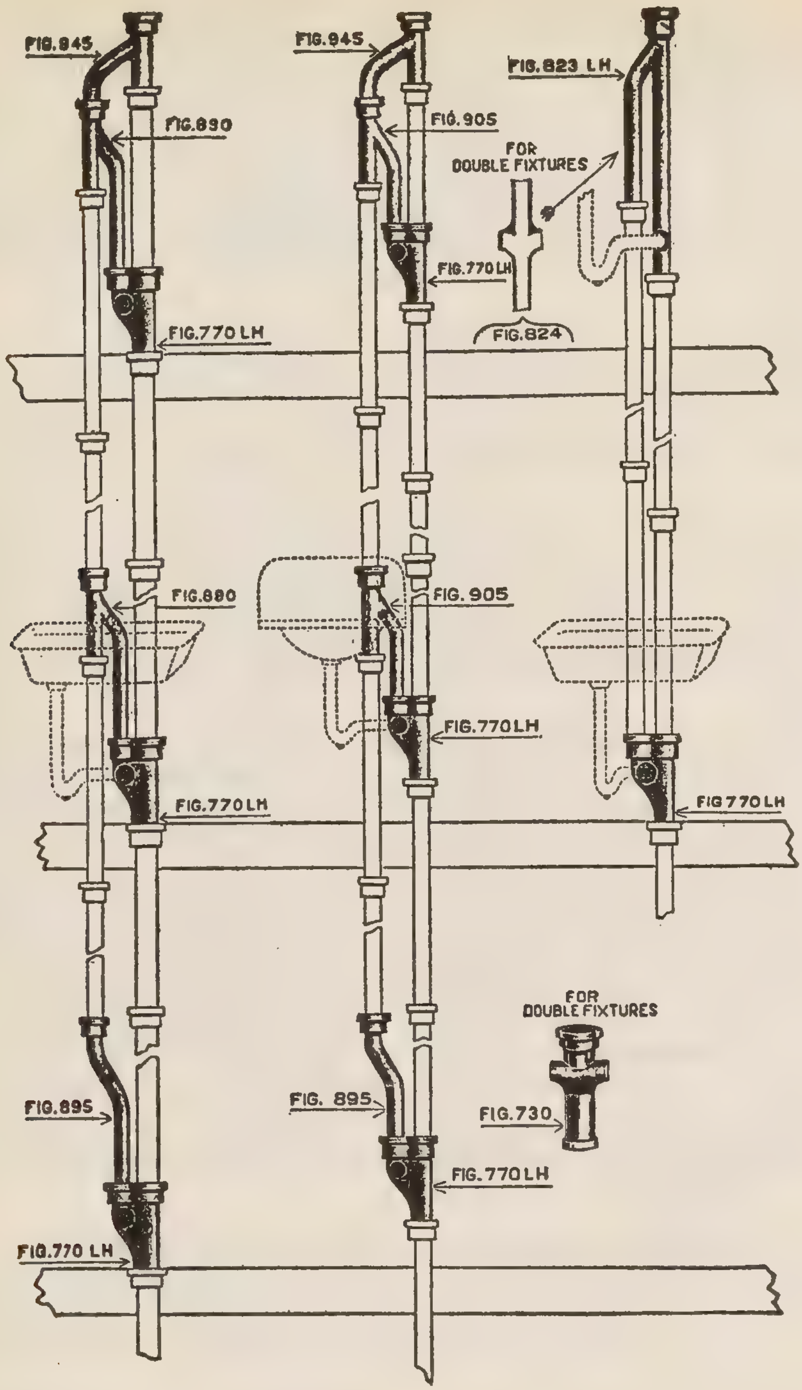
The present tendency in plumbing is to reduce pipe sizes *entirely too much* owing to the high cost of material and labor.

Three inch soil pipes are commonly used instead of four inch; also closets with 3 in. traps are in common use. In the opinion of the author this should not be tolerated just to save a few dollars. This should be evident to anyone, unprejudiced, by noting how a 3 inch closet labors to clear itself, and frequently it fails unless the entire contents of the tank be discharged.

The average person will not bother to hold the valve open for a full discharge and sometimes it happens that such closets do not fully clear themselves; in such cases, the next flushing sometimes causes the bowl to overflow. An installation of this kind serving the same fixtures as in the preceding examples is shown in fig. 6,999. This represents a combination of the caulked joint and threaded joint system using cast iron and wrought pipe and fittings. The degree of skimping is evident by comparing it with the preceding examples, although it goes for first class plumbing. Note the violation of the ventilation principle in piping the drains to the stack leg of the loop instead of to the offset branch leg. This is done so that the branch leg may be reduced in size regardless of the fact that the ventilation current up the stack is reversed during each trap discharge with resulting objectional puff back or discharge of gases through the fresh air inlet.

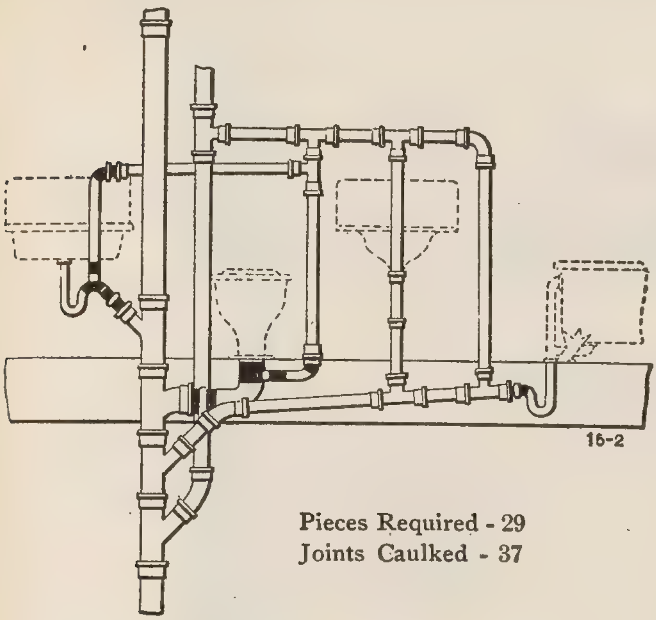
It will be understood that the examples thus far given are very small installations and the objectionable features mentioned are not of such importance as they would be in larger installations.

The small installations are purposely given so as to bring out the details more clearly by permitting the illustration to

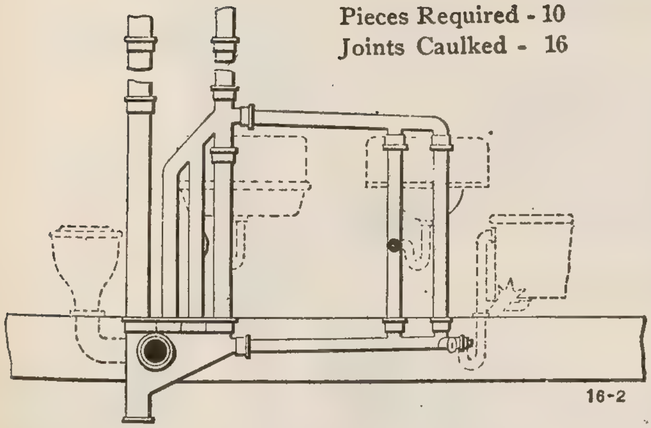


FIGS. 7,001 to 7,005.—F. and W. special fittings. 1, fig. 7,001, combination for sink connections as per dotted lines; fig. 7,002, combination for basin; fig. 7,003, combination as specially arranged for sink connection in two family apartments. Note where double fixtures are used that 834 is substituted for 823, and 730 for 770.

be produced on a larger scale, and so as not to confuse the student by showing a maze of pipe work.



REGULAR FITTINGS



Pieces Required - 10
Joints Caulked - 16

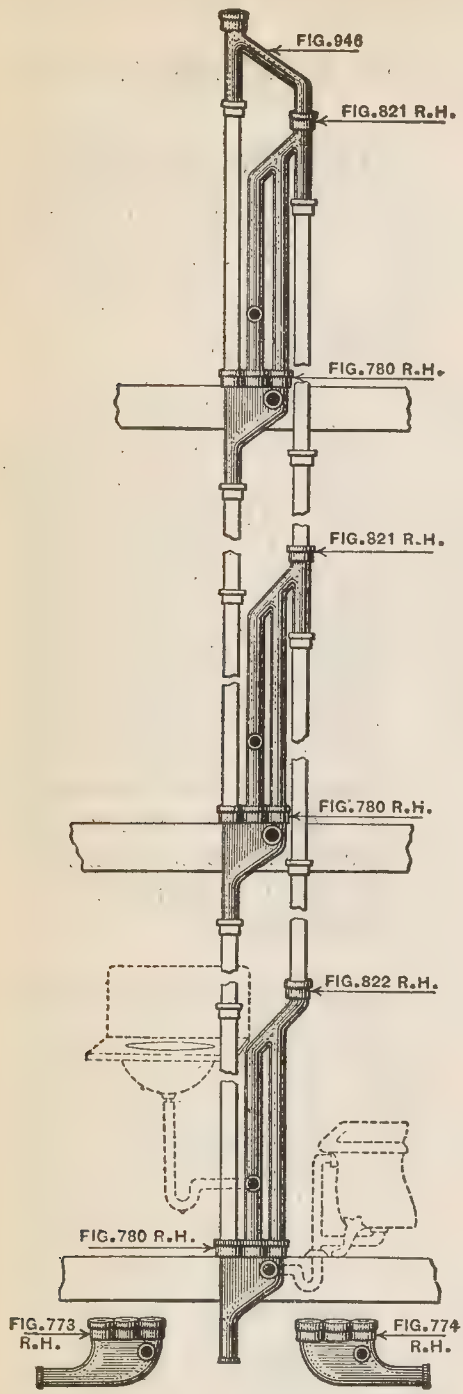
SPECIAL FITTINGS

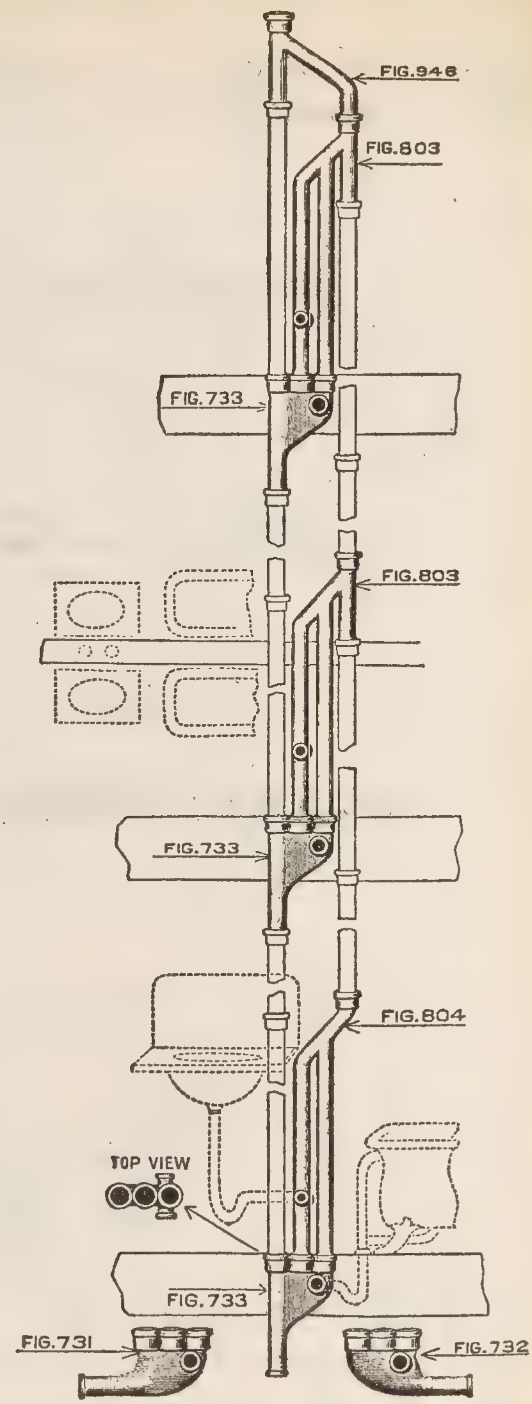
FIGS. 7,006 and,007.—Comparison of regular and special fittings showing saving in joints on a four fixture installation.

Thus far, installations have been shown in cast iron and lead and in combined cast iron and wrought pipe.

Fig. 7,000, shows the installation with Durham system, that is with all wrought pipe and recessed screwed fittings (called *drainage fittings*), it follows the same arrangement as fig. 6,993, with the exception that the loop has legs of equal area as should be and waste and vent lines are connected to the proper legs so that there will be no reversal of air current during fixture discharge.

Use of Special Fittings in Roughing In Work.—The installations thus far considered are made with ordinary form fittings usually carried in stock. The advantage is that the dealer is more likely to have these fittings on hand rather than the unusual

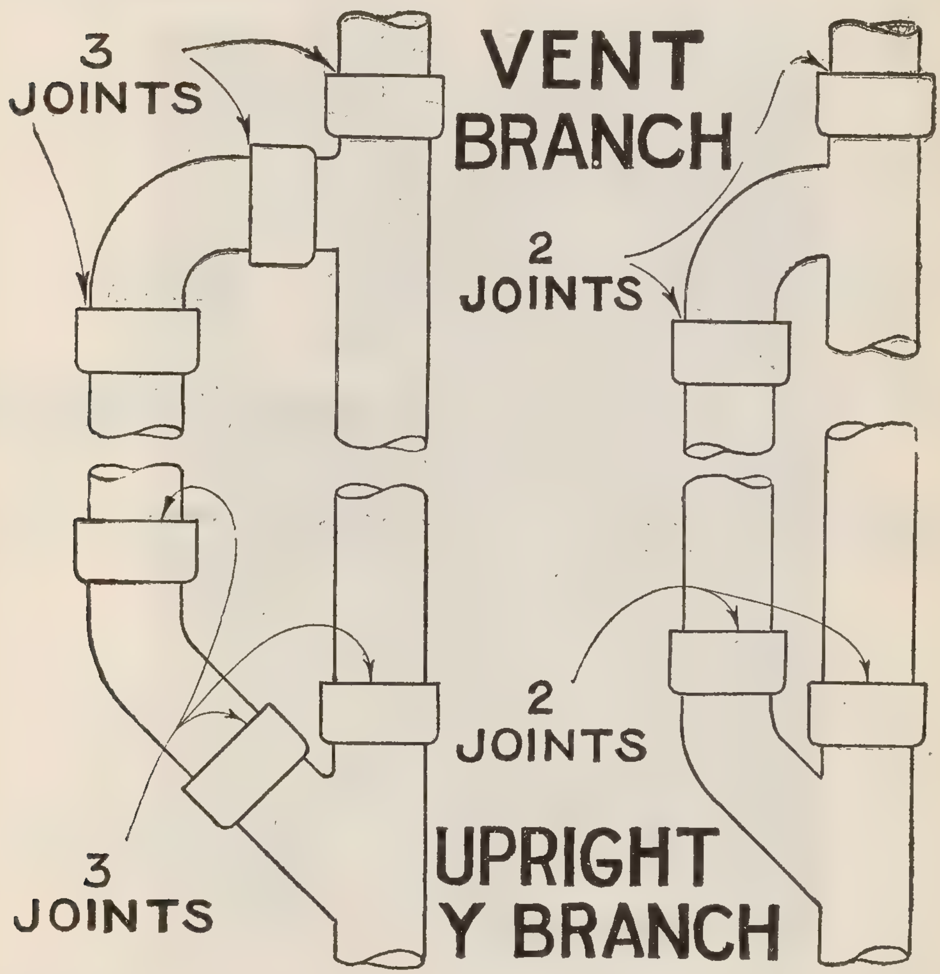




FIGS. 7,008 to 7,010.—F. and W. special fittings. 2, Combination for 2 or 3 in. line arranged for bath tub and basin, or bath tub and sink. Note that 773 and 774 can be used where lines break or offset.

FIGS. 7,011 to 7,014.—F. and W. special fittings. 3, Combination arranged for a 2 or 3 in. line of double bath tubs and basins or double bath tubs and sinks. 731 and 732 can be used where lines break or offset.

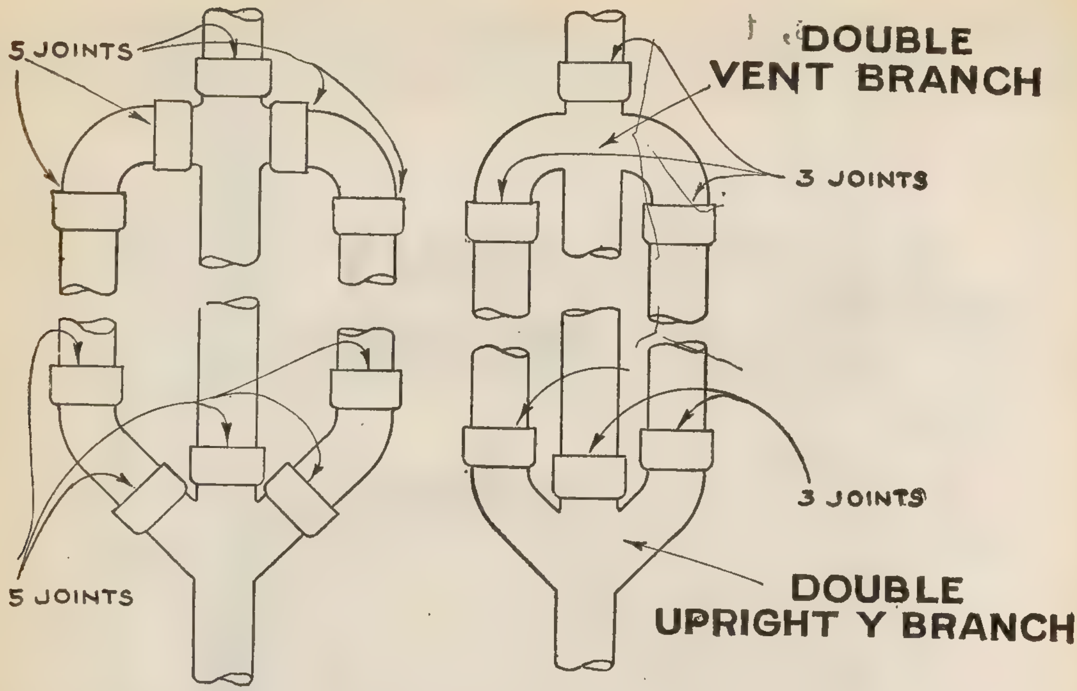
or special forms, thus the chances of delay in delivery are less when the ordinary fittings are specified. However the in-



FIGS. 7,015 and 7,016.—***Roughing in with ordinary and special fittings.*** 1, Stack with ventilation loop. Saves two joints.

stallation will have more joints and not be as simple as when special fittings are used.

Thus fig. 7,015 shows a ventilation loop stack made with ordinary fittings and fig. 7,016 the same using special fittings, a saving of two joints as



FIGS. 7,017 and 7,018.—***Roughing in with ordinary and special fittings.*** 2, stack with double vent branches. Saves four joints.

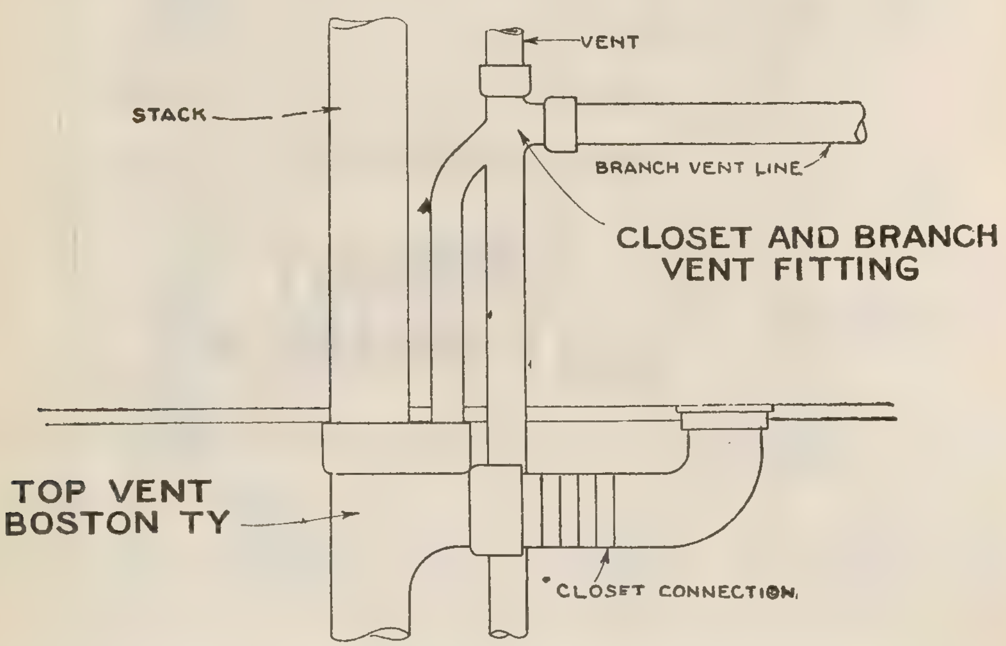


FIG. 7,019.—Roughing in with special fittings. 1, closet and branch vent fitting and Boston top vent TY, giving closet ventilation and connection for branch vent line.

indicated in the figure. Thus there is less cost for labor and less number of joints reducing the chances of leakage.

Similarly figs. 7,017 and 7,018 show stack with double vent branches.

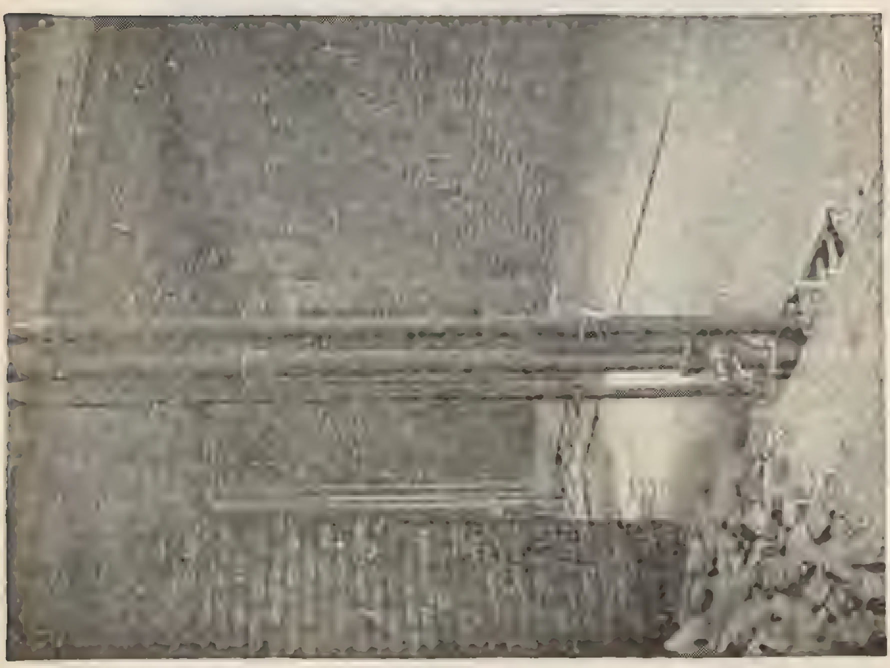
The double upright Y branch shown in fig. 7.018 is not generally made, if available the two special fittings save four joints.

The use of a top vent Boston TY, and a closet and branch vent fitting

FIG. 7,020.—Installation with F. and W. special fittings. 7, Plumber assembling No. 70C combination for a double closet line.

is shown in fig. 7,019. This combination gives closet ventilation and connection for a branch vent line for other fixtures.

The Boston top vent TY, may also be obtained in the double pattern to serve two closets. The reduction in joint and simplicity secured by the use of the three special fittings shown assembled in fig. 7,030 must be apparent. This combination permits the closet connection to be at right angles to the plane of the ventilating loop.



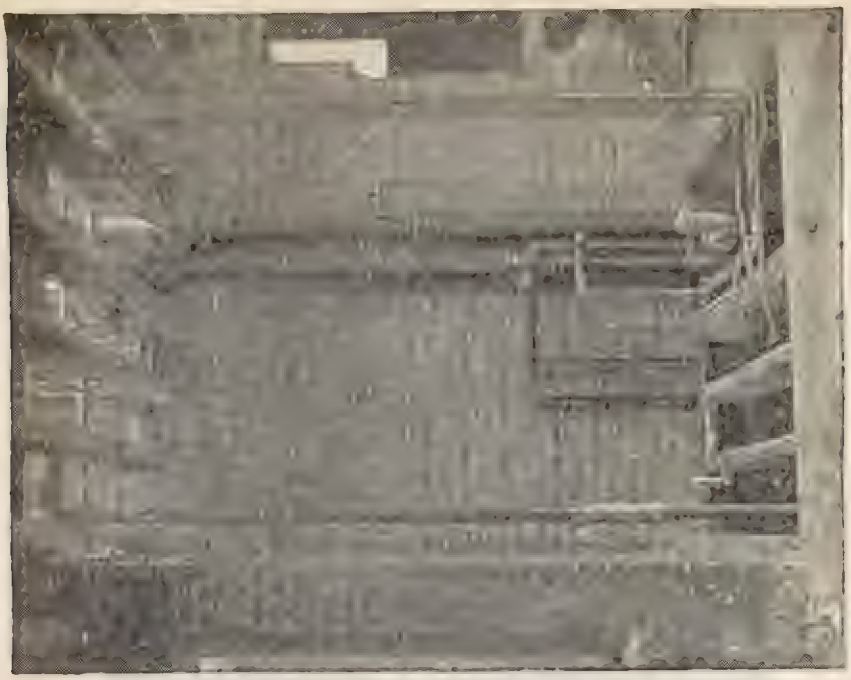
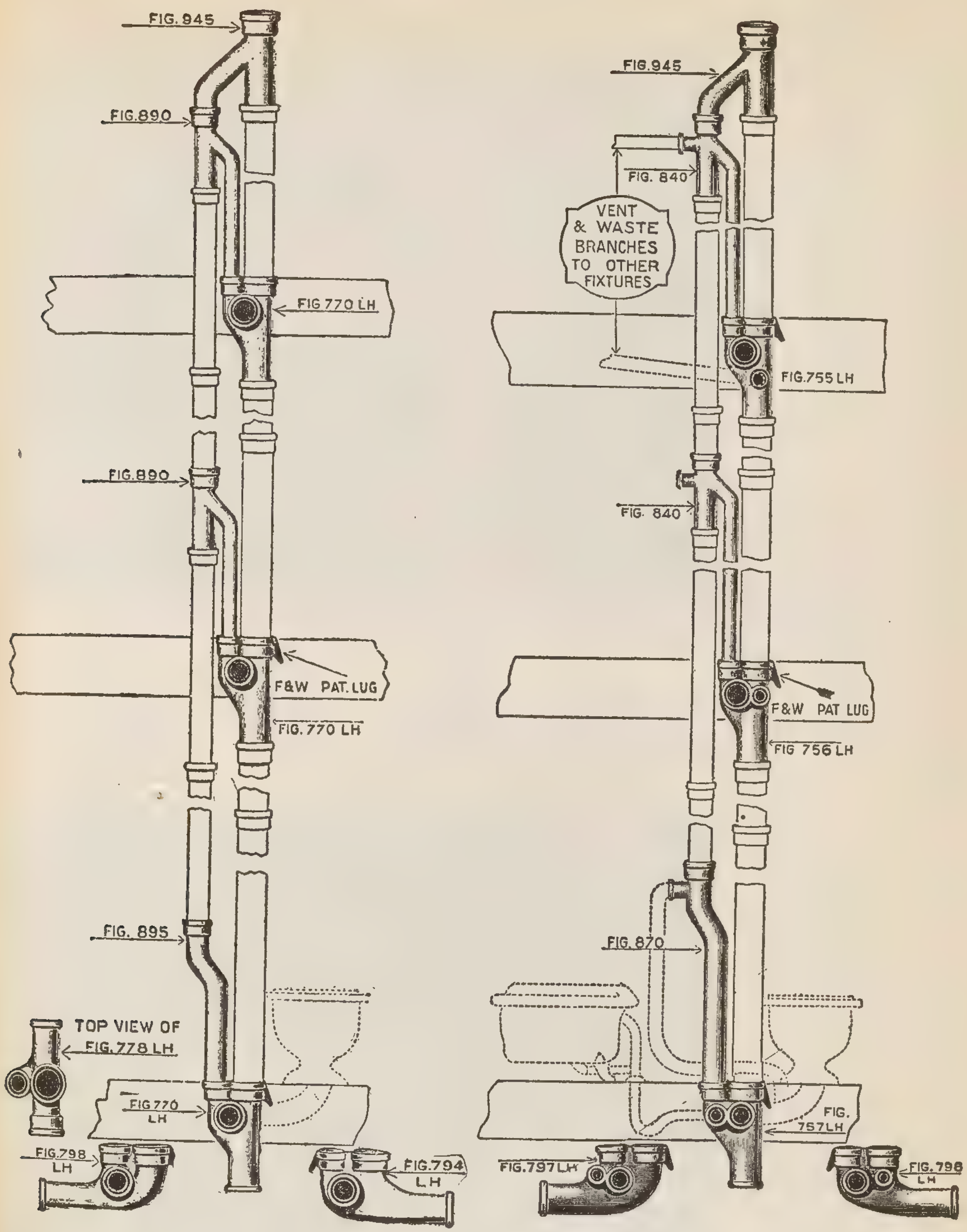


FIG. 7,021.—Installation with F. and W. special fittings. 5. Independent sink and wash tray line using No. 770 combination.

FIG. 7,022.—Installation with F. and W. special fittings. 6. Closet, lavatory and bath arranged close against wall using No. 740 combination.



FIGS. 7,023 to 7,026.—F. and W. special fittings. 4, Combination arranged for a single closet line. 778, 794, and 798 can be used where lines break or offset.

FIGS. 7,027 to 7,029.—F. and W. special fittings. 5, Combination arranged for closet and bath or other fixtures. 796 and 797 can be used where lines break or offset.

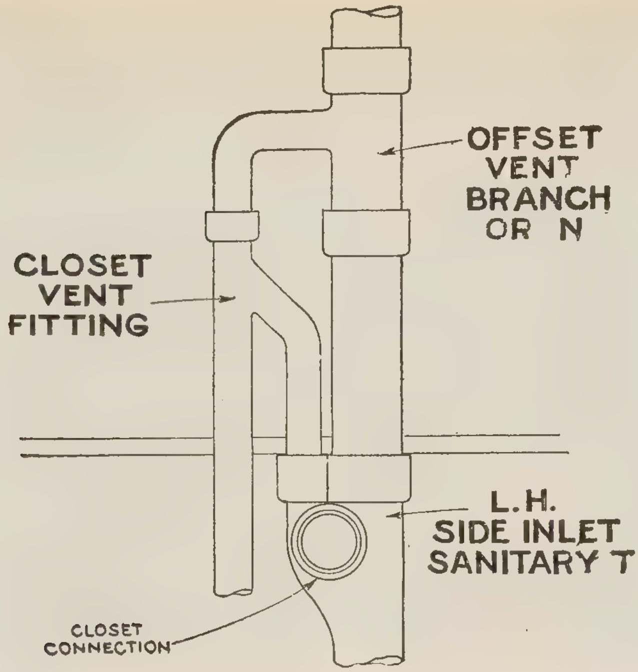


FIG. 7,030.—Roughing in with special fittings. 2, L.H. side inlet sanitary T, used in combination with closet vent fitting and offset vent branch or "N."

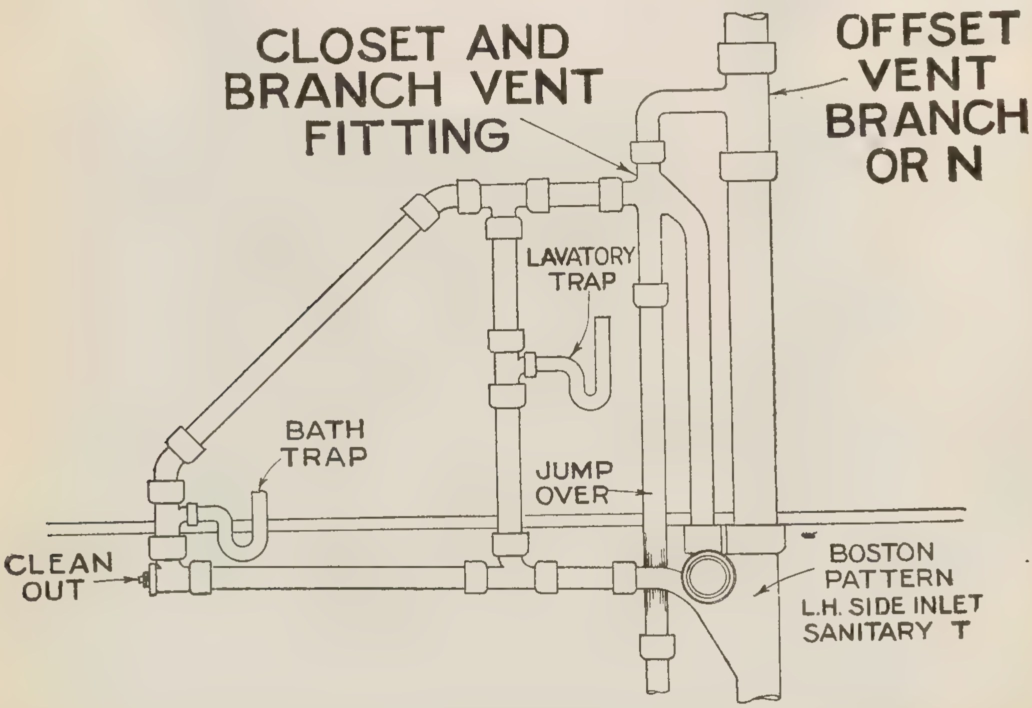
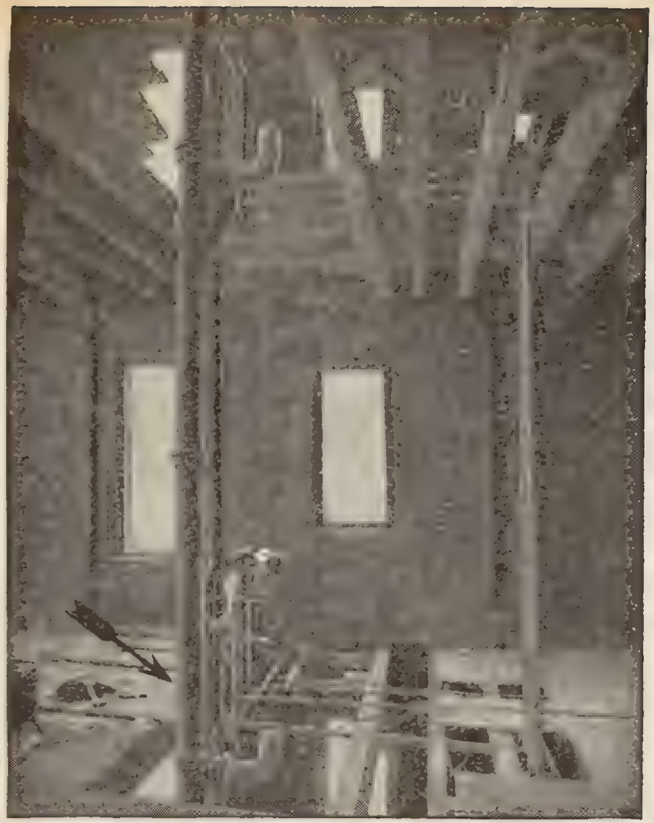


FIG. 7,031.—Roughing in with special fittings. 3, Boston pattern L.H. side inlet sanitary T, used in combination with closet and branch vent fitting, and "jump over."



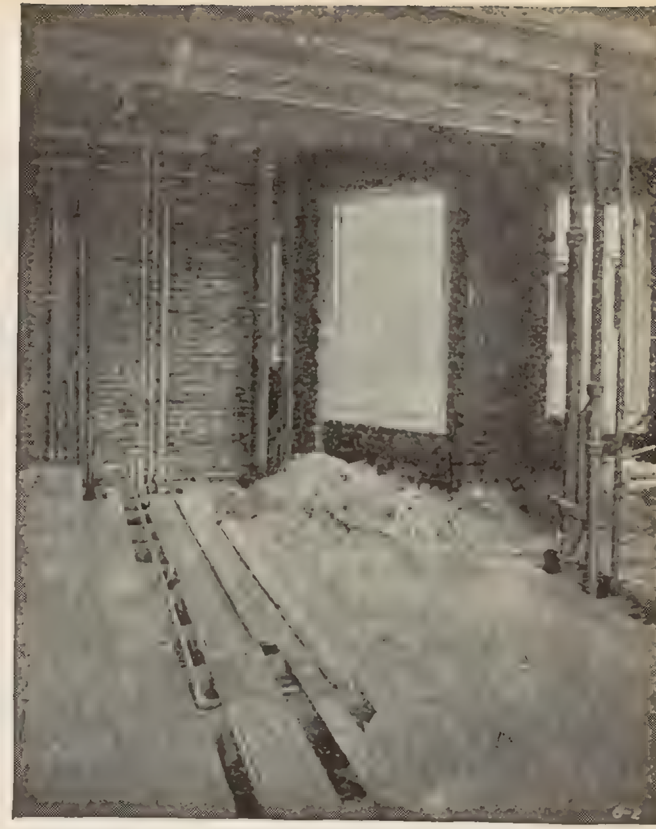
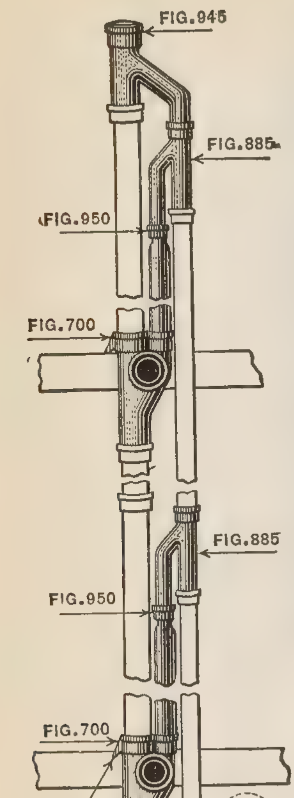
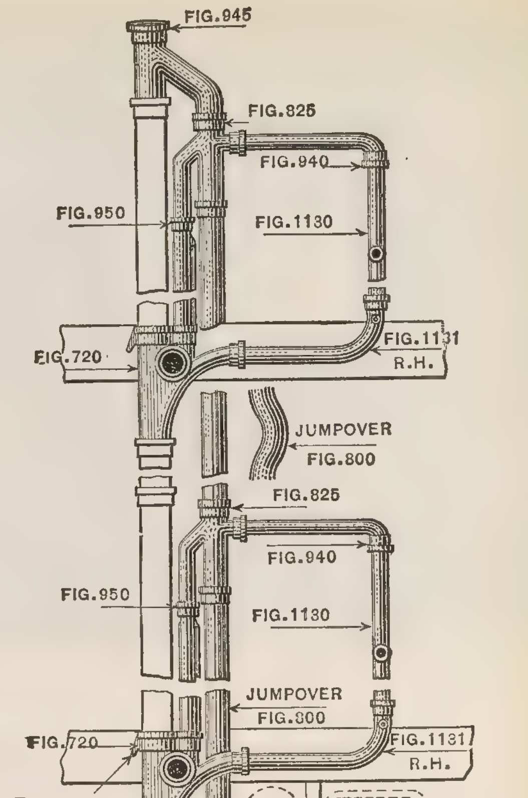


FIG. 7,032.—Installation with F. and W. special fittings. 3, Combination showing closet, bath, lavatory, sink and wash tray using No. 748. The arrow indicates position of sink and wash tray opening in the fitting.

FIG. 7,033.—Installation with F. and W. special fittings. 4, At left is shown arrangement of bath and lavatory line using No. 780 combination. In the center is independent closet line using No. 770 combination. On the right is an independent sink and wash tray line using No. 770 combination.

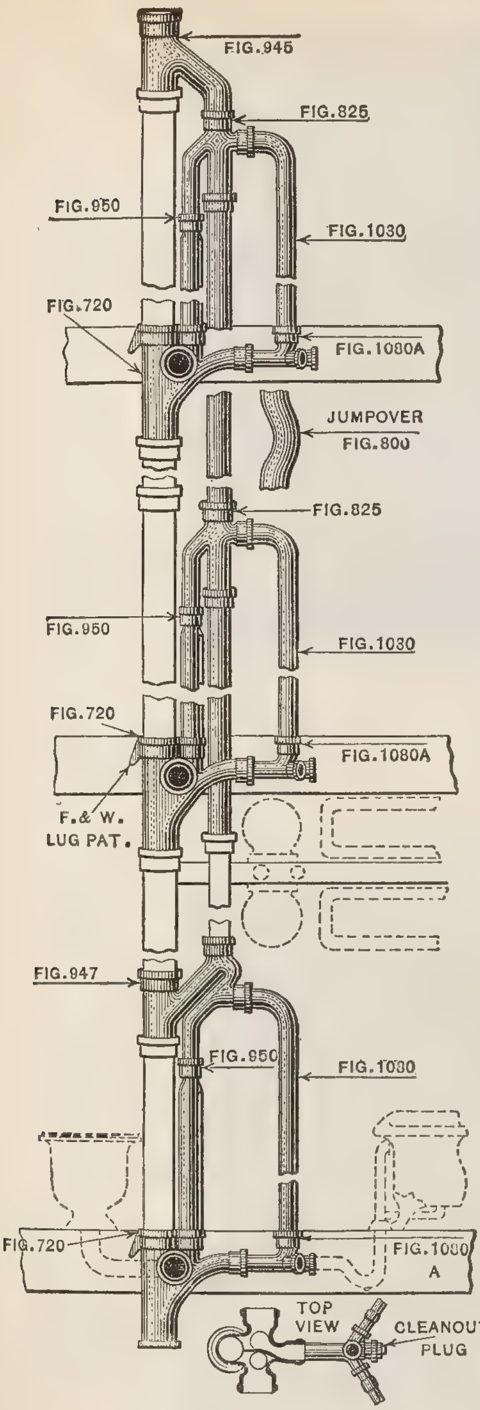
Fig. 7,031, shows the same type sanitary T as in fig. 7,030, but having an inlet as shown for waste from lavatory and bath tub. A branch vent line serves these fixtures, connecting with the vent leg of

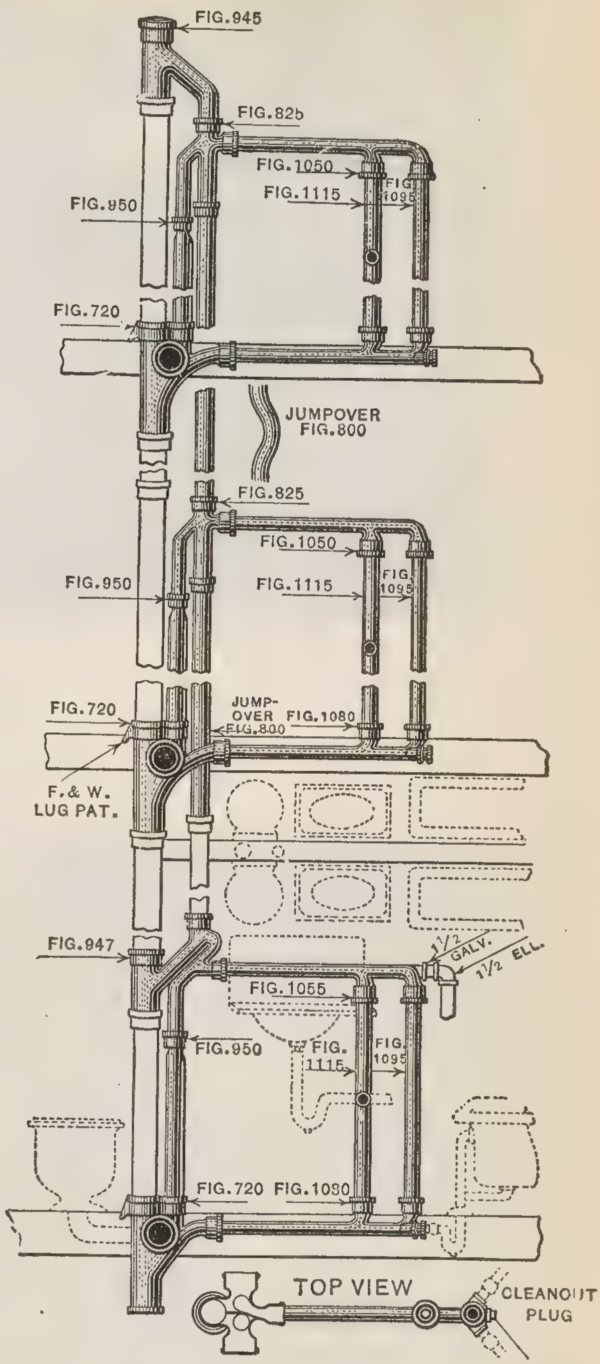




Figs. 7,034 and 7,035.—F. and W. special fittings. 6, Combination arranged for double closets.

Figs. 7,036 to 7,038.—F. and W. special fittings. 7, Combination arranged for double closets and sinks.





Figs. 7,039 to 7,041.—F. and W. special fittings. 8, Combination arranged for double closets and baths.

Figs. 7,042 to 7,044.—F. and W. special fittings. 9, Combination arranged to suit fixtures shown, illustrating expecially fitting No. 947 and vent to basement fixtures.

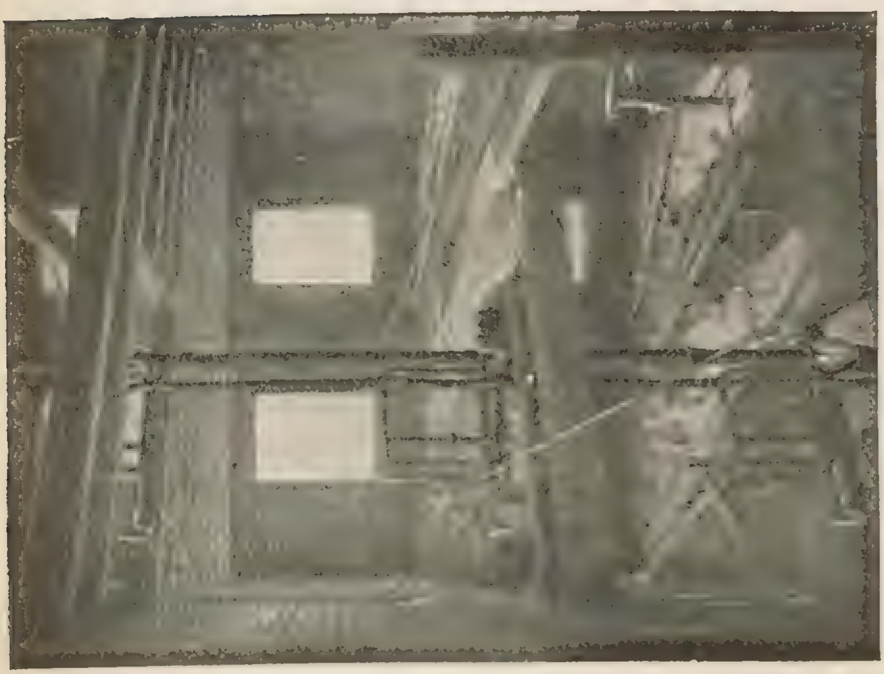
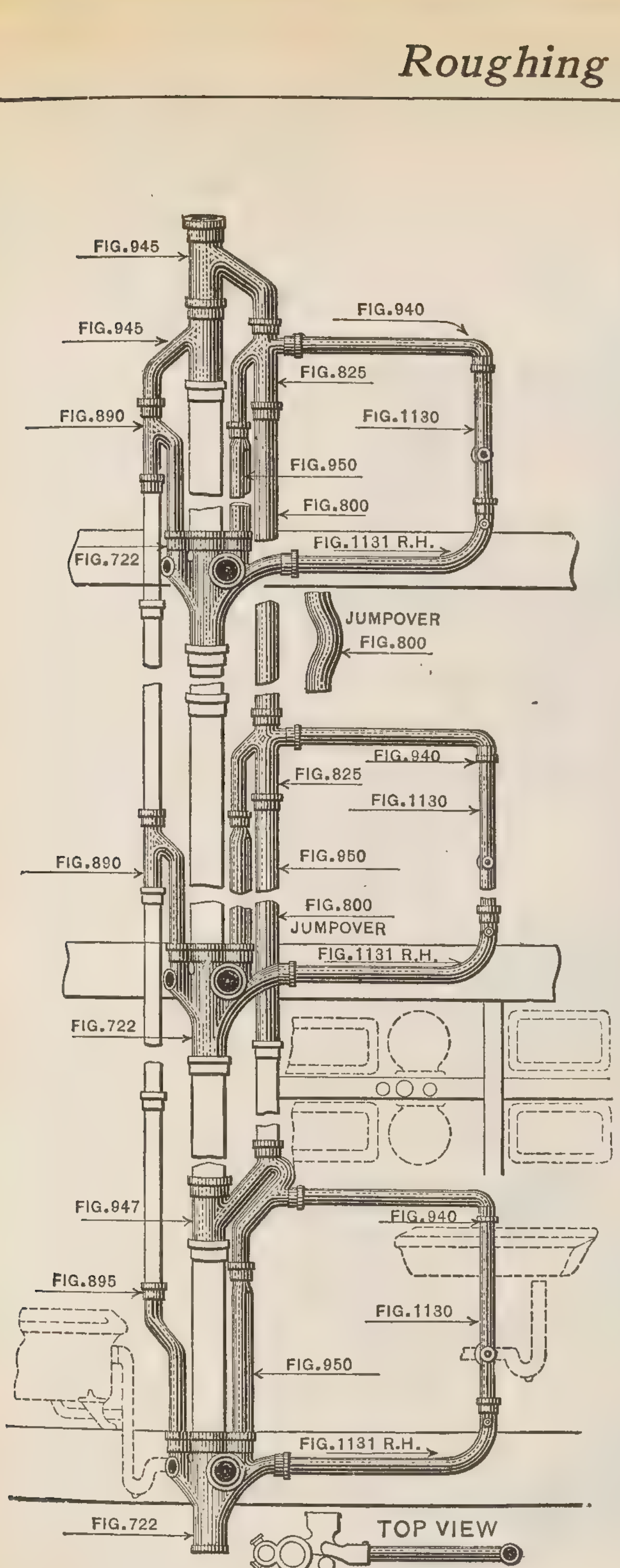


FIG. 7,044.—Installation with F. and W. special fittings. 1, Combination showing three floor roughing in for closet, lavatory and bath tub, using No. 740. Note the jump over fitting clearing No. 740.

FIG. 7,045.—Installation with F. and W. special fittings. 2, Double bath room with No. 708 combination serving both closets, the lavatory and bath tub of each bath room being served by No. 780 combination.

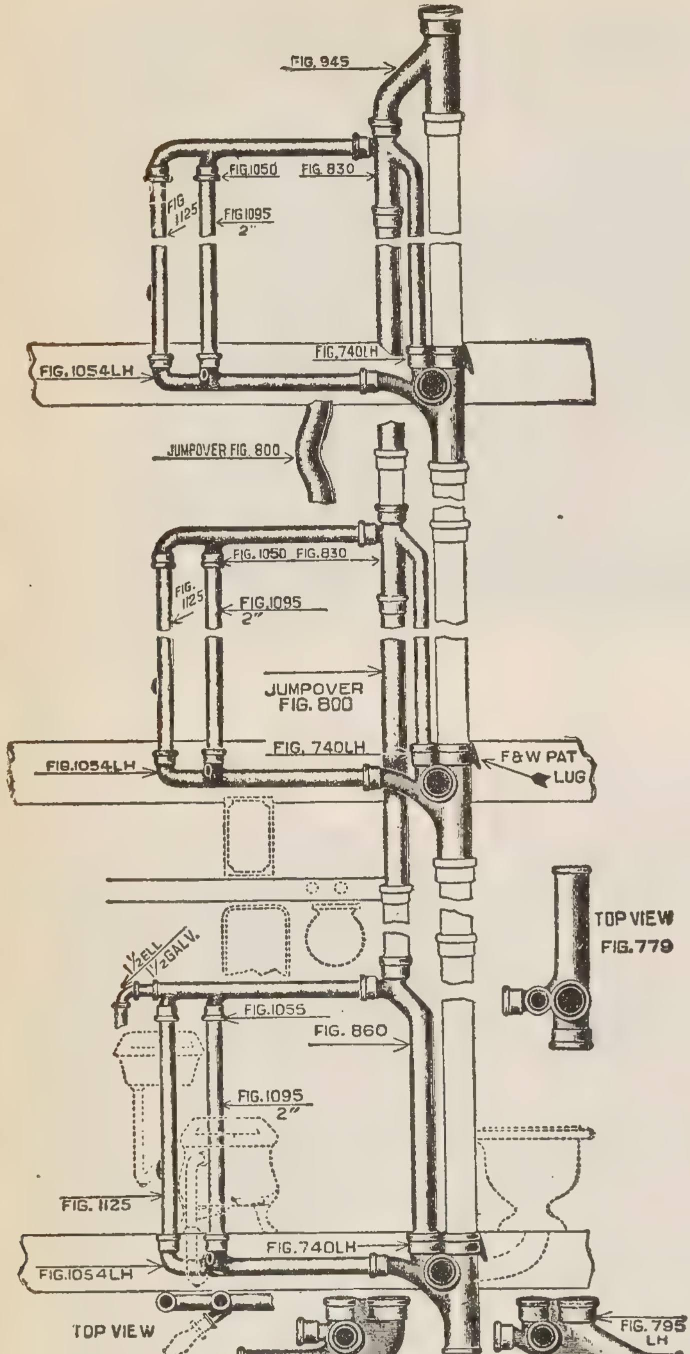


the loop by means of the closet and branch vent fitting. Note how the vent leg of the loop is carried past the waste inlet of the sanitary T by means of a "jump over" which is simply a length of pipe having a curved offset at the right point. Evidently the jump over avoids the use of two offset fittings.

There is a great variety of combinations that may be made with special fittings so that roughing in for any assemblage of fixtures may be accomplished in the most efficient manner, giving proper drainage and ventilation without unnecessary complication of piping.

In addition to the examples of these already shown, a few of the great multiplicity of arrangements possible are shown in figs. 7,001 to 7,094 illustrating the F & W system.

FIGS. 7,046 to 7,048.—F. and W. special fittings. 10, Combination arranged to suit fixtures shown, illustrating especially No. 722 which provides for one soil and two vent lines.

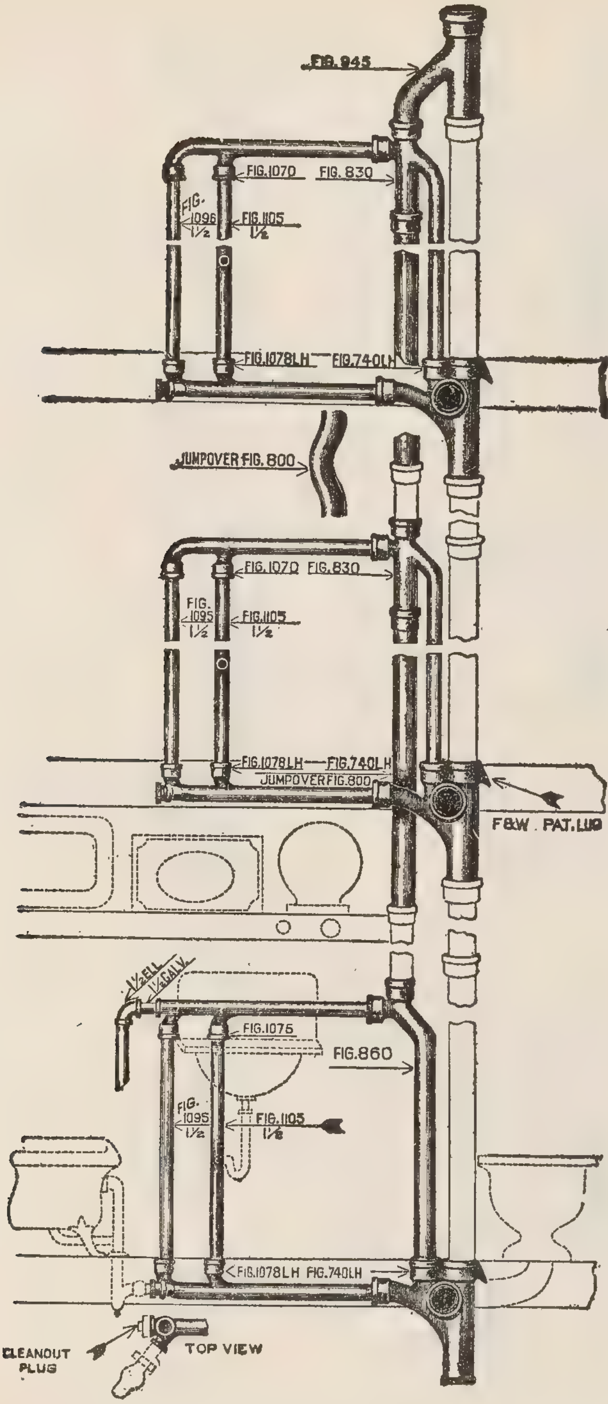


FIGS. 7,049 to 7,054.—F. and W. special fittings. 11, Combination arranged to suit fixtures shown. 779, 795, and 799 can be used where lines break or offset.

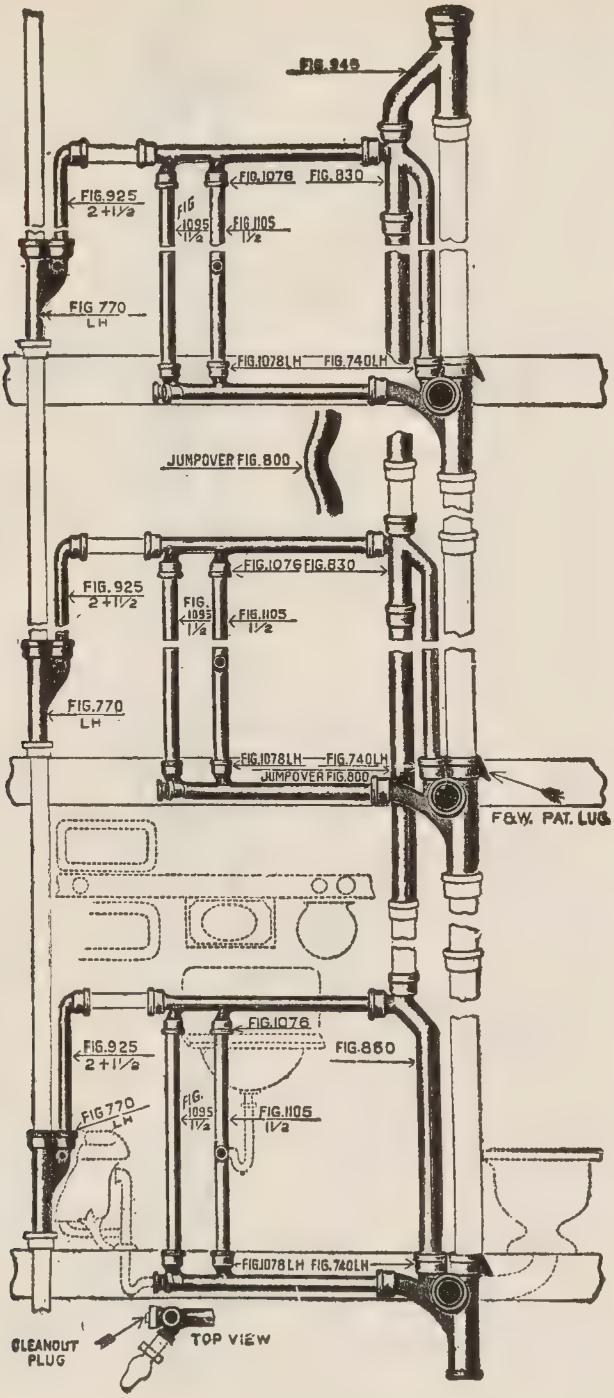
Each of these fittings eliminates two or more regular fittings thus reducing the number of joints and amount of room required between partitions.

NOTE.—In the F. & W. system, it is claimed that as fast as rust forms in the vent pipe, it falls into the drainage part of their special tee, from which it is carried away by the flow of water from the sanitary fixtures. In this invention it can be readily seen that an important improvement has been made. They have also invented a series of special fittings shown in the accompanying illustrations for venting and reventing, by which perfect ventilation is maintained at all times. It is also claimed that F. & W. Fittings require less room between partitions than other systems; that they are cheaper and when properly connected, are practical, sanitary and durable.

NOTE.—When drainage pipe was first put into living apartments, no attempt was made to prevent the air contained therein from escaping into the rooms, but it was soon found that disease and even death came to those who were unfortunate enough to live in an atmosphere which man has since discovered to be laden with microbes. To prevent the escape of poisonous gases from the pipe, a self-sealing trap was invented and effectively applied. The trap is gas proof as long as the seal remains perfect, but it was demonstrated that syphonage often took place when the pipe was flushed, thus breaking the seal and admitting sewer gas to the living rooms. To prevent syphoning water from the trap and the disastrous results sure to follow, an air pipe, called the ***vent pipe,*** was connected to its crown and extended through the roof.



FIGS. 7,055 and 7,057.—F. and W. special fittings. 12, Combination arranged to suit fixtures shown in dotted lines.



FIGS. 7,058 and 7,060.—F. and W. special fittings. 13, Combination arranged to suit fixtures shown in dotted lines.

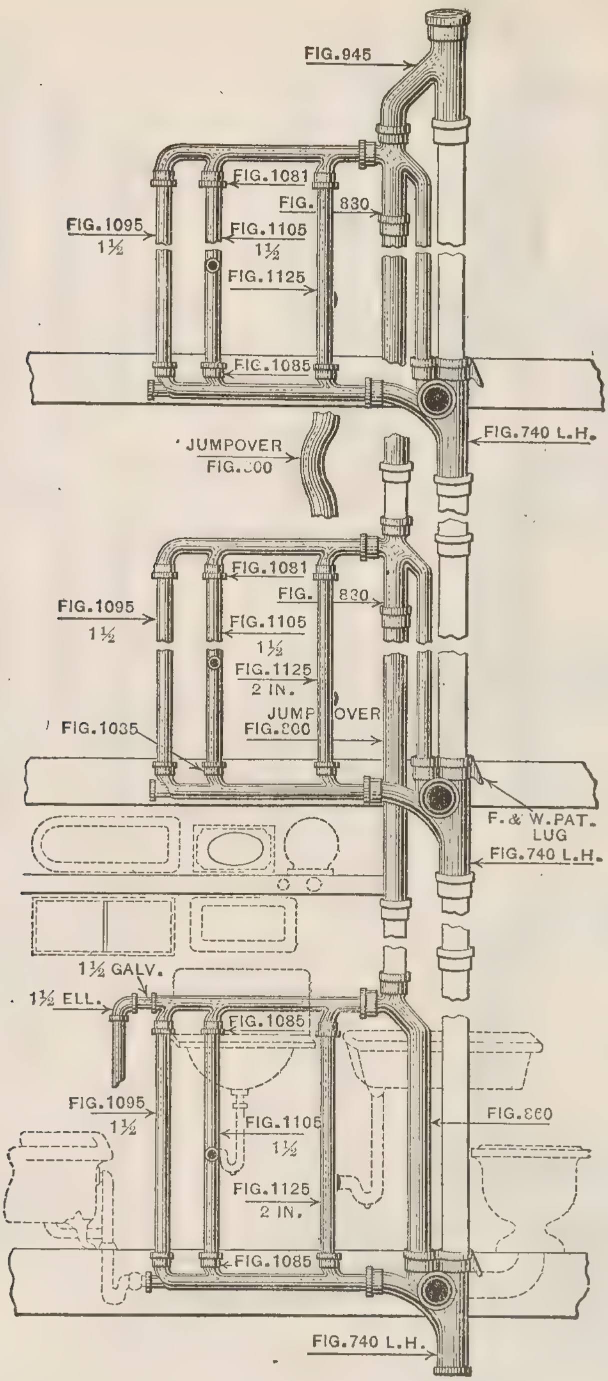
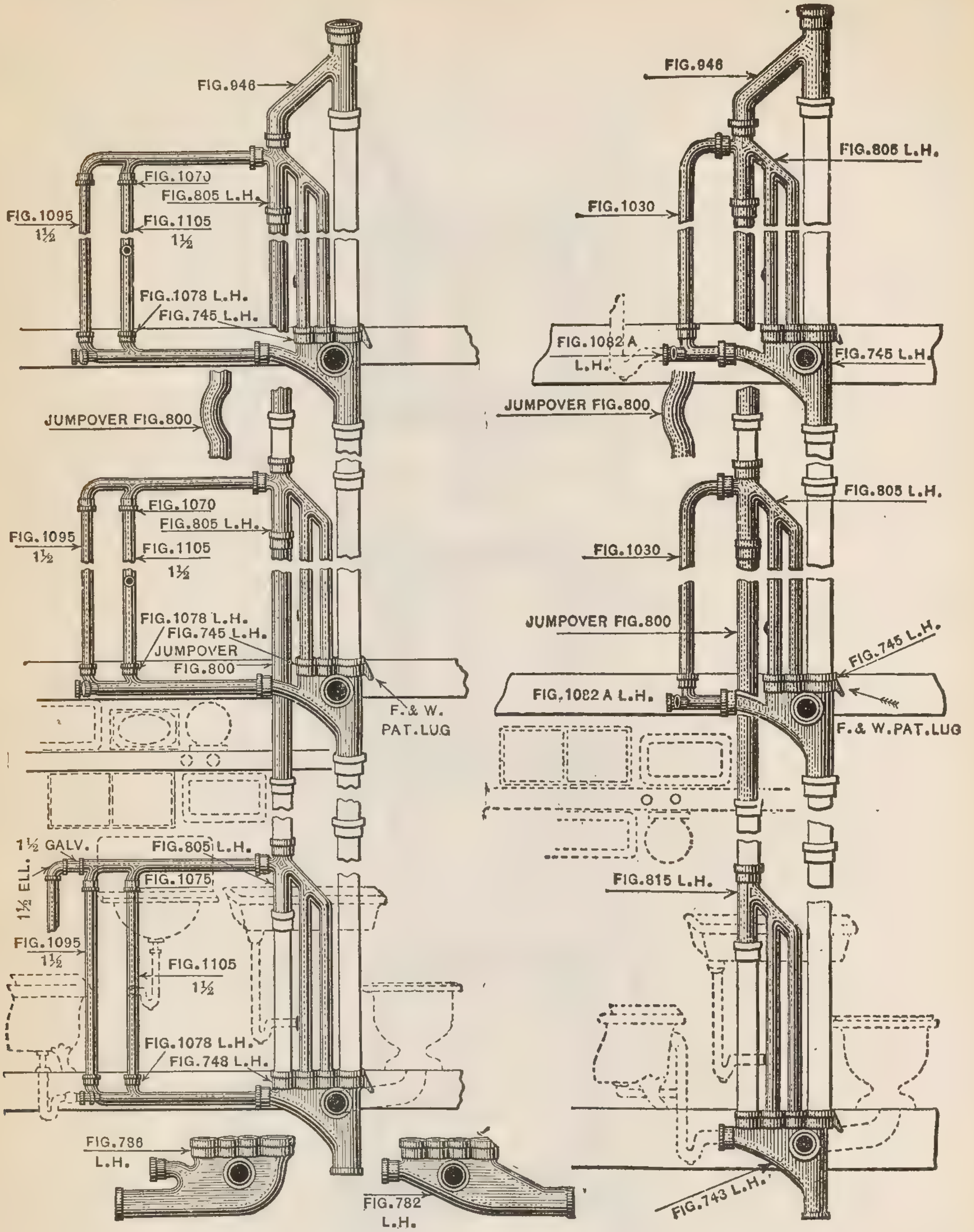
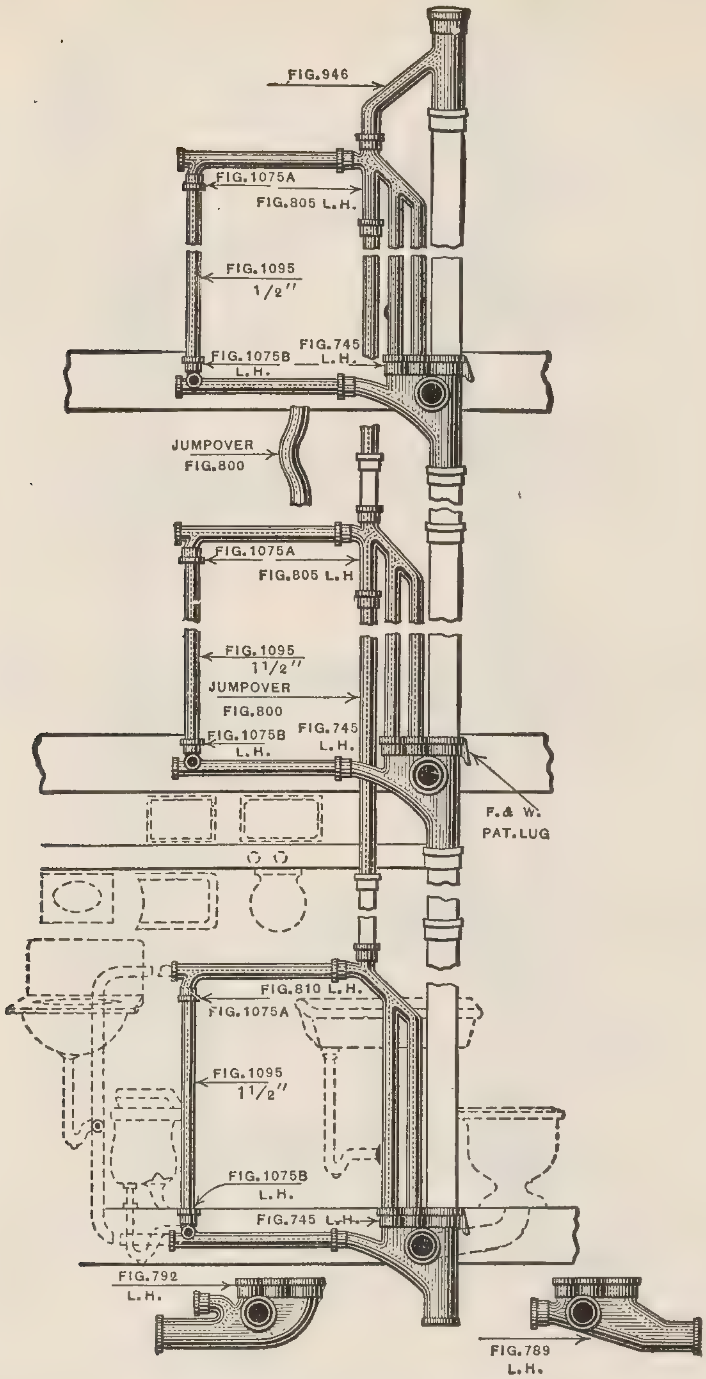


FIG. 7,061 and 7,062.—F. and W. special fittings. 14, Combination arranged to suit bath room and kitchen fixtures.

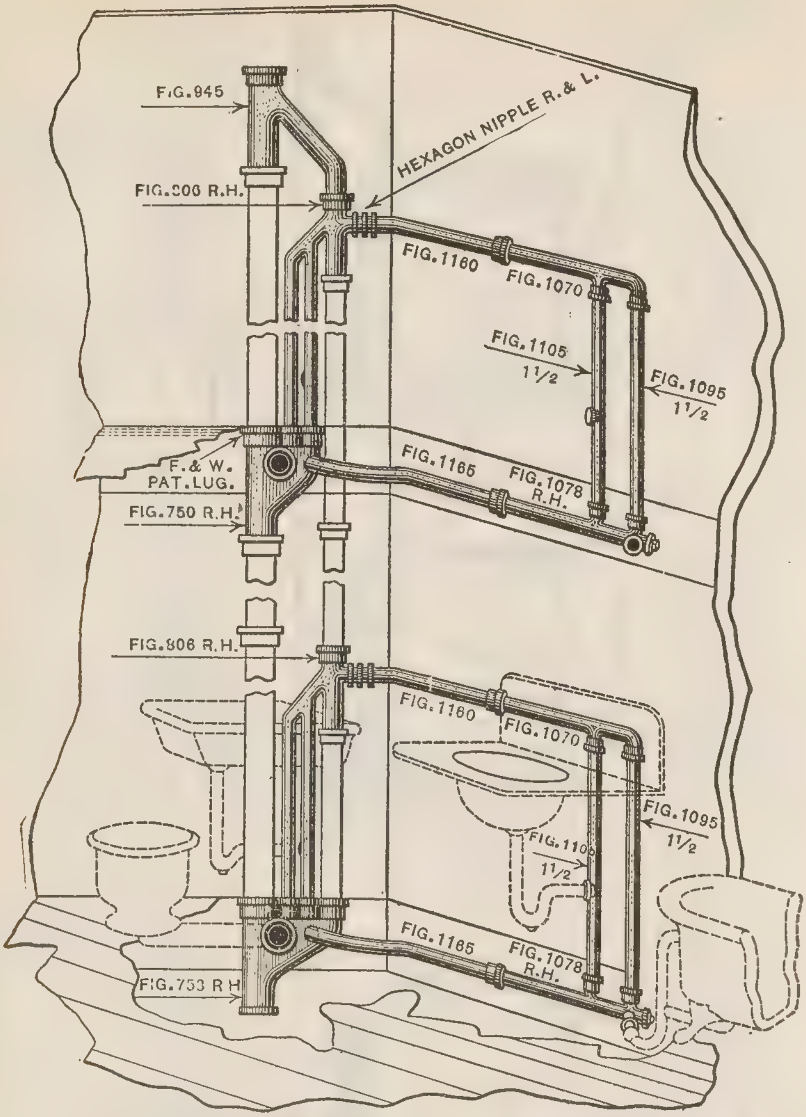


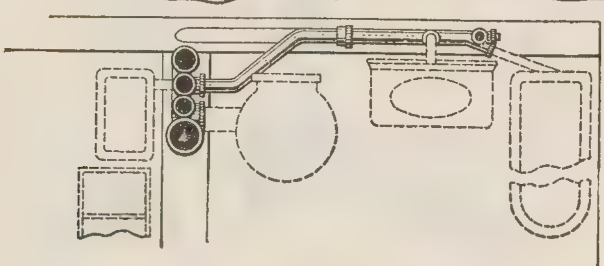
FIGS. 7,063 to 7,066.—F. and W. special fittings. 15, Combination to suit bath room and kitchen fixtures. 782 and 786 can be used where lines break or offset

FIG. 7,067 and 7,068.—F. and W. special fittings. 16, Combination arranged to suit a line of closets, sinks and bath tubs.

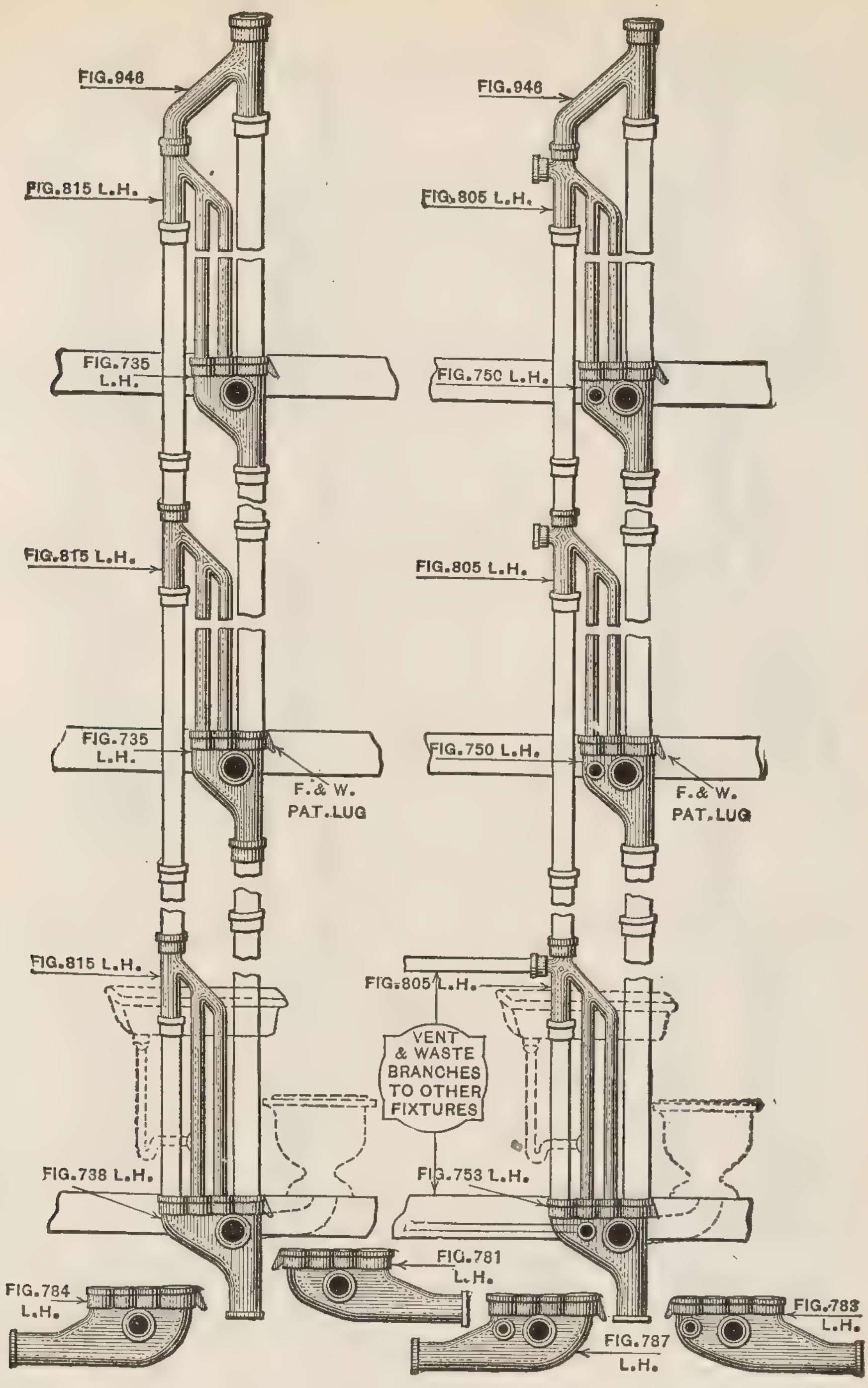


FIGS. 7,069 to 7,072.—F. and W. special fittings. 17, Combination arranged to suit fixtures shown in dotted lines. 789 and 792 can be used where lines break or offset.



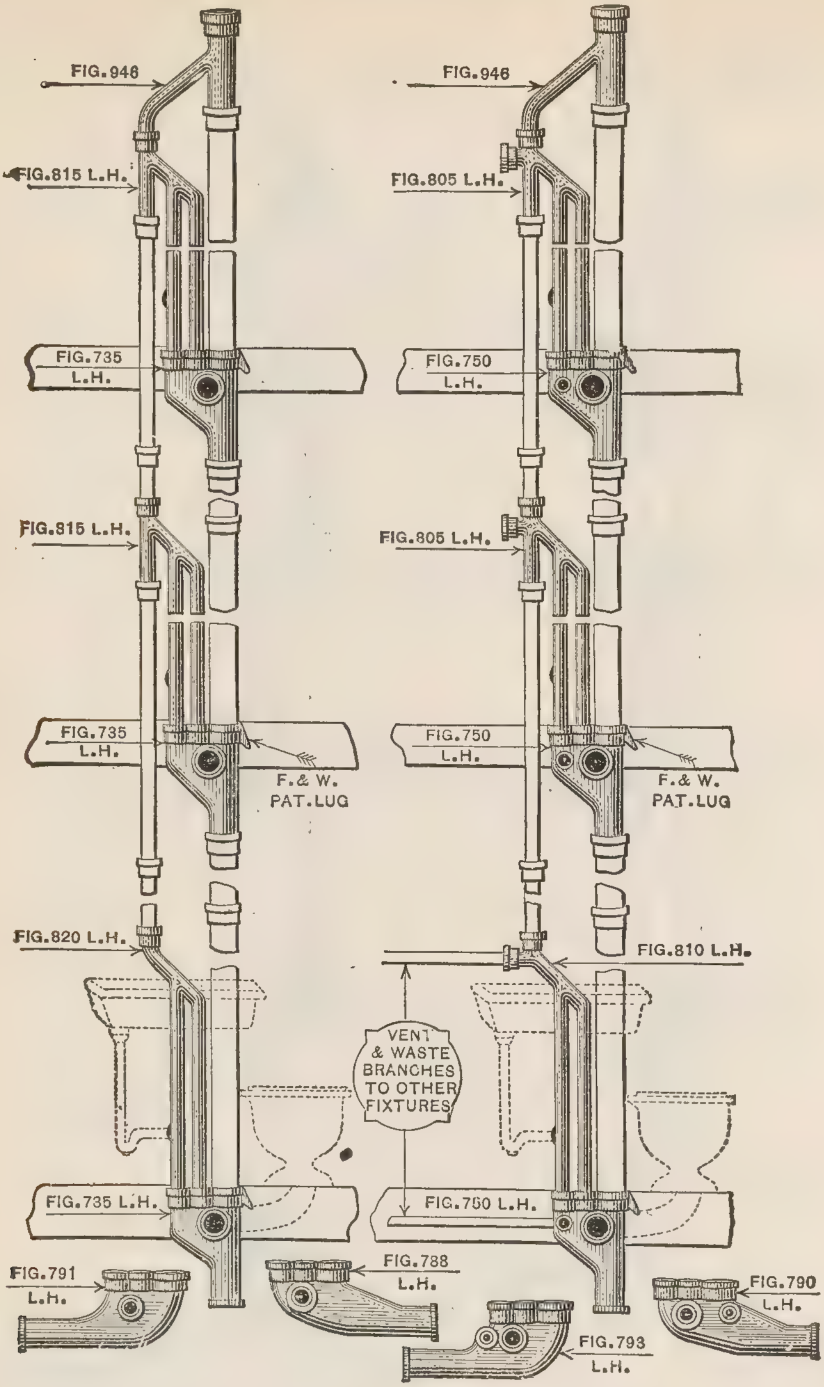


FIGS. 7,073 and 7,074.—F. and W. special fittings. 18, Combination arranged to suit fixtures shown in dotted lines; bath and basin at right angles to partition in which lines are run.



FIGS. 7,075 to 7,077.—F. and W. special fittings. 19, Combination arranged to accommodate a line of closets and sinks. 781 and 784 can be used where lines break or offset.

FIGS. 7,078 to 7,080.—F. and W. special fittings. 20, Combination arranged to suit fixtures shown in dotted lines; note lugs or rests for supporting soil pipe lines. 783 and 787 can be used where lines break or offset.



FIGS. 7,081 to 7,083.—F. and W. special fittings. 21, Four inch pipe line and 2 in. revent line arranged to suit closet and sink. 788 and 791 can be used where lines break or offset.

FIGS. 7,084 to 7,086.—F. and W. special fittings. 22, Four inch soil pipe line and 2 in. revent line arranged to suit closet, sink, laundry tubs, bath, or other fixtures. 790 and 793 can be used where lines break or offset.

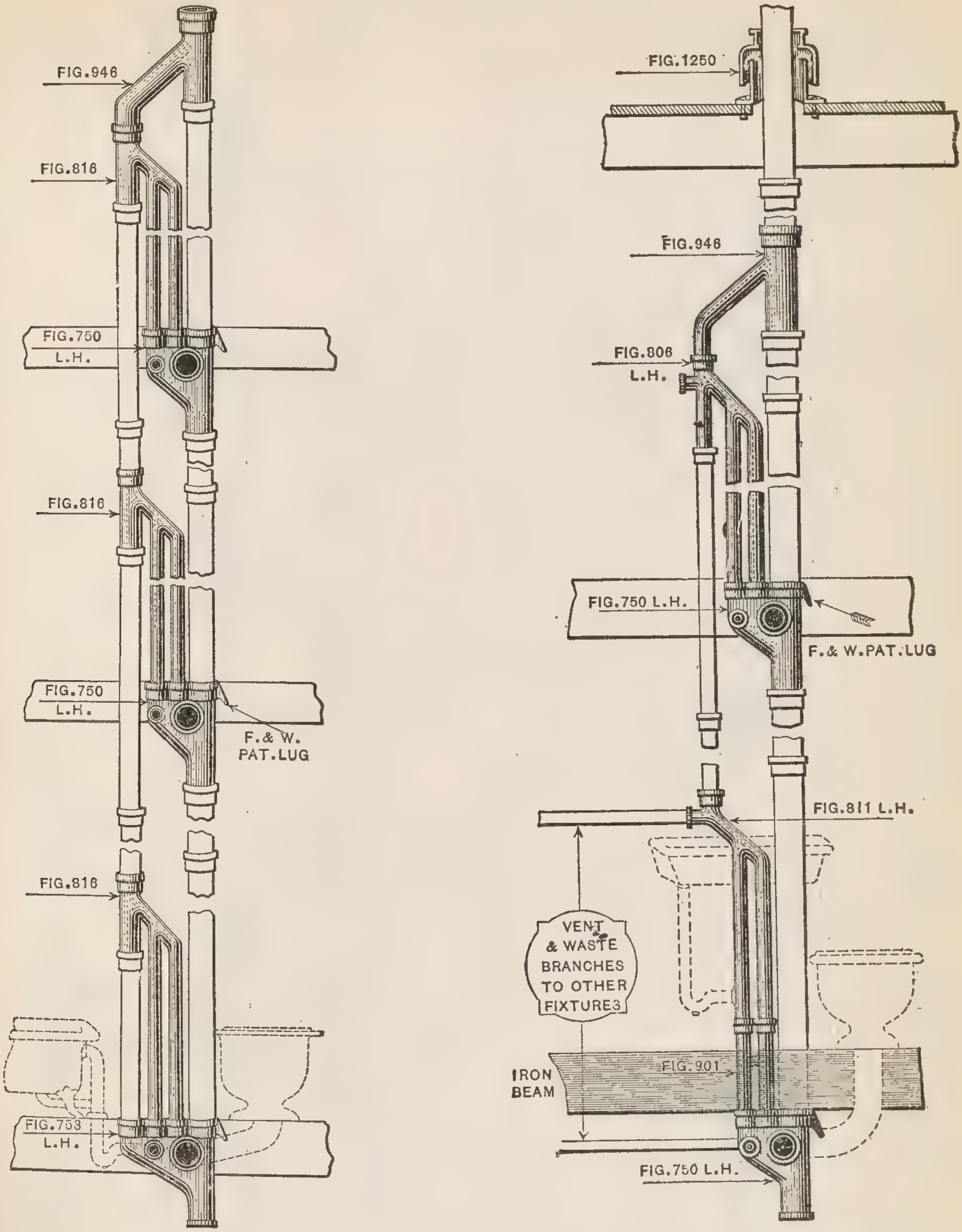
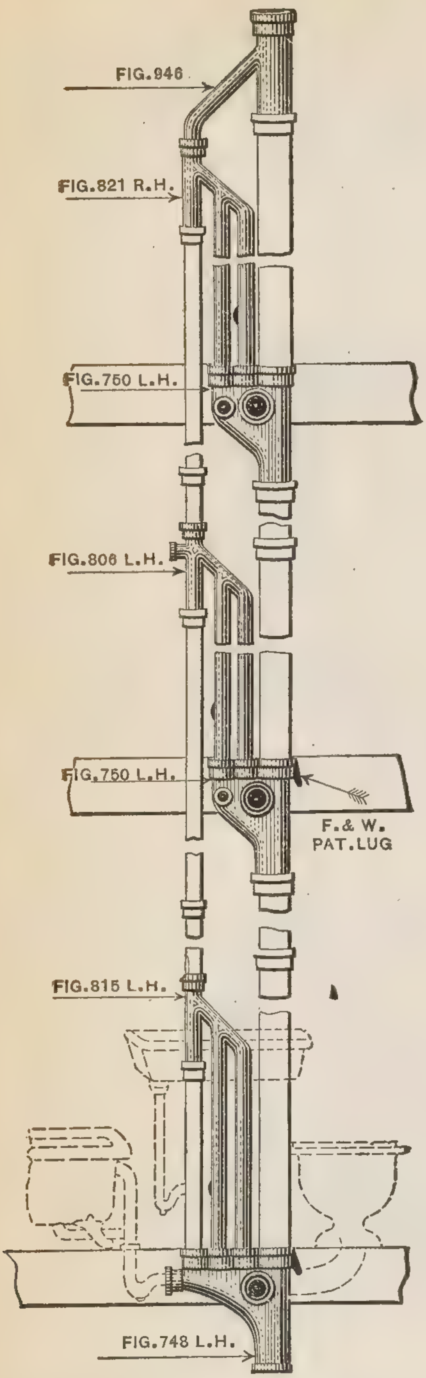


FIG. 7,087.—F. and W. special fittings. 23, Combination arranged for a line of closets and bath tubs.

FIG. 7,088.—F. and W. special fittings. 24, Combination arranged for fixtures shown in dotted lines, illustrating especially frost proof iron roof plate No. 1250, and attic foul air vent intended to prevent the choking up of ventilation pipe by hoar frost. 901 can be used when necessary to put closet openings below iron beam.



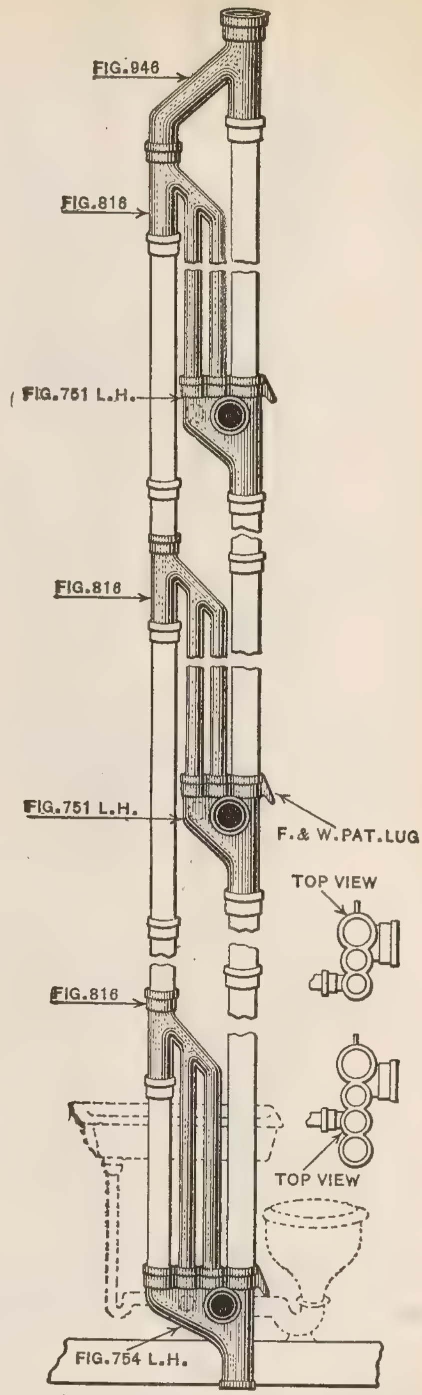
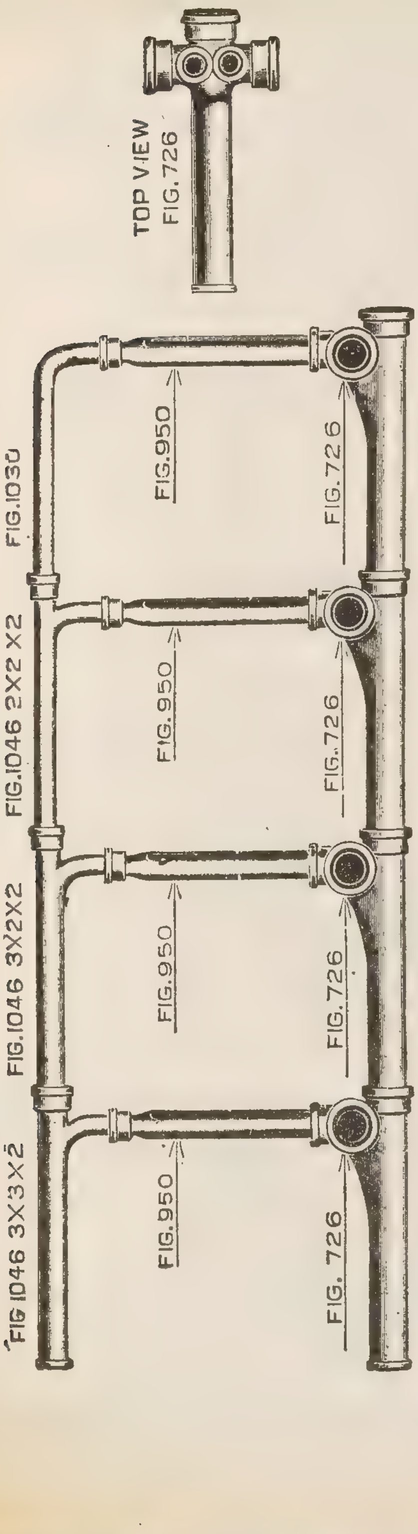


FIG. 7,089.—F. and W. special fittings. 25. Combination arranged to suit fixtures shown in dotted lines. Note on top and bottom floors all fixtures are completely vented and on center floor bath tub only requires reventing, inlet for which is provided by 806.

FIGS. 7,090 to 7,092.—F. and W. special fittings. 26, Combination arranged for a closet and sink line with closet opening above the floor, where short hopper and P trap are used.



FIGS. 7,093 and 7,094.—F. and W. special fittings. Combination arranged to suit a battery of double closets.

Vent Connections to Traps.—A trap to be satisfactory should be self-scouring, and non-syphonable. But these two features cannot be obtained in the same type trap. In fact there is no trap that cannot be syphoned, the nearest approach to this being the drum trap, but it is not self scouring like the S trap. The latter, while self-scouring is easily syphoned and accordingly unless its waste line have very little pitch and discharge into the stack above a closet inlet (one pipe systems) it should be ventilated.

The ordinary method of connecting the vent to the crown of an S trap is very objectionable because it causes maximum evaporation of the trap water and the inlet to vent soon becomes clogged, thus preventing entrance of air to break syphon.

Fig. 7,095 shows how seal is lost due to rapid evaporation produced by the vent inlet being placed in close proximity to the surface of the trap water.

Again in the everyday operation of an S trap with crown vent the centrifugal force produced by the rush of water through the curved

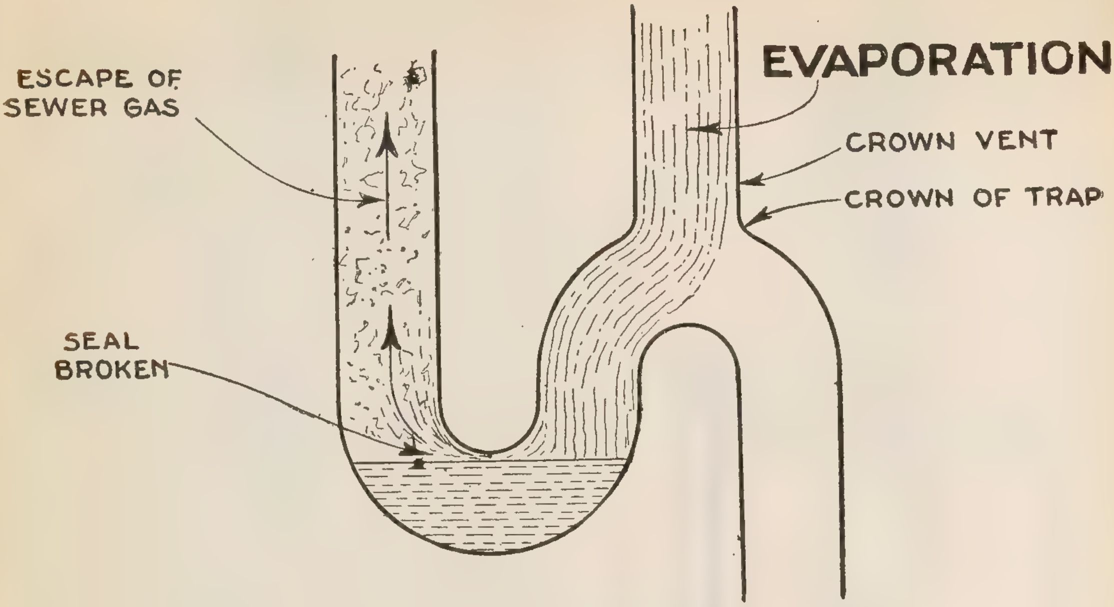
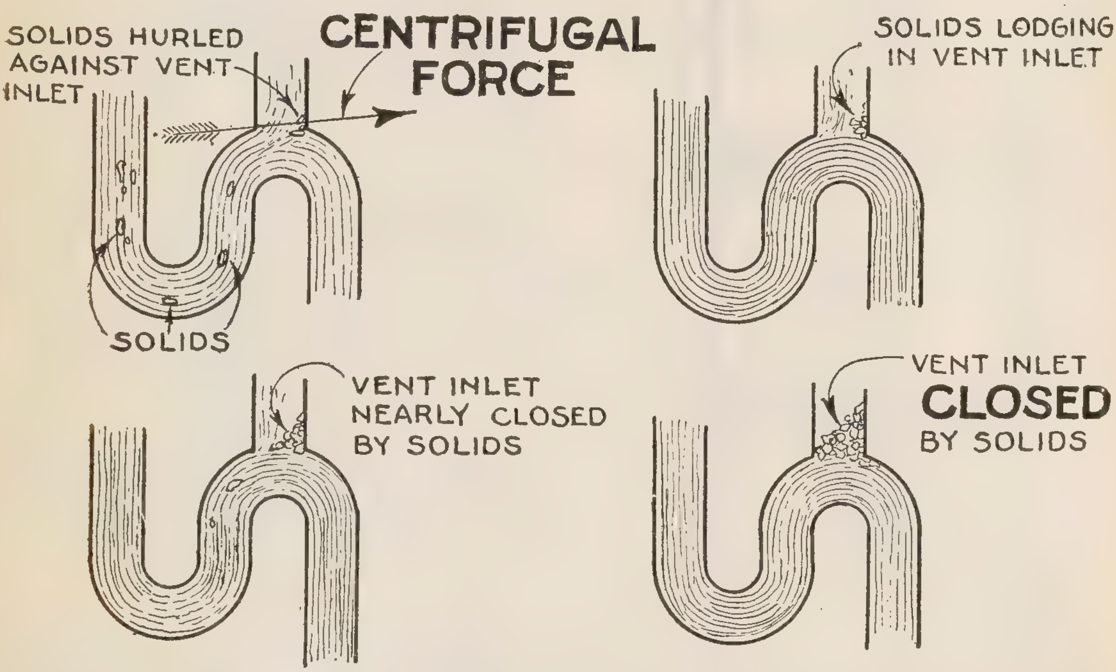


FIG. 7,095.—Crown vent on S trap showing seal broken by evaporation.

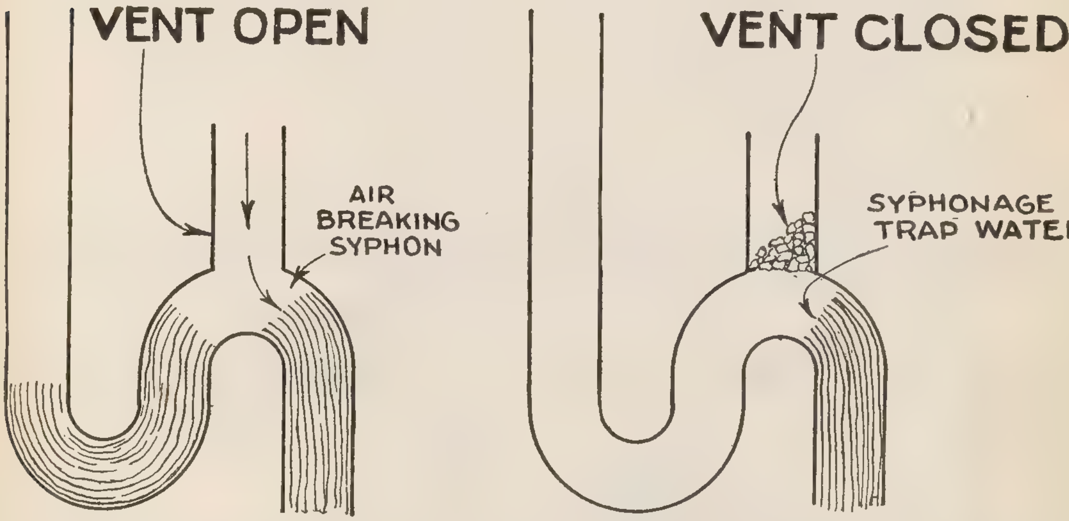


FIGS. 7,096 to 7,099.—Progressive closing of crown vent on S trap due to centrifugal force throwing solid matter against and into vent.

crown carries particles of grease and other impurities to be hurled up against and into the vent pipe. These attach themselves to the vent pipe, progressively building up until the vent becomes closed and rendered useless as shown in figs 7,096 to 7,099.

Fig. 7,100 shows vent operating to break syphon before it is closed up by lodgment of impurities, and fig. 7,101, result when closed.

Fig. 7,102 shows the proper method of venting an S trap and fig. 7,103, the satisfactory operation of same.



Figs. 7,100 and 7,101.—Operation of S trap with crown vent when clean and when choked with solid matter showing that placing a vent in the crown of an S trap is a useless provision against syphonage.

The drum trap although it is most difficult to syphon should be vented if every precaution is to be taken against syphonage. However, in small installations, drum, traps are frequently installed without venting.

If venting is to be employed, the S trap, because of its self scouring feature is to be preferred. The special use of the drum trap is for bath tubs as it is easily cleaned and also it permits a better pitch on the waste line than the S trap. While the drum can be easily cleaned it is almost impossible to open the clean out without destroying the gasket and when closing the clean out unless the gasket joint be perfect, gas will escape.

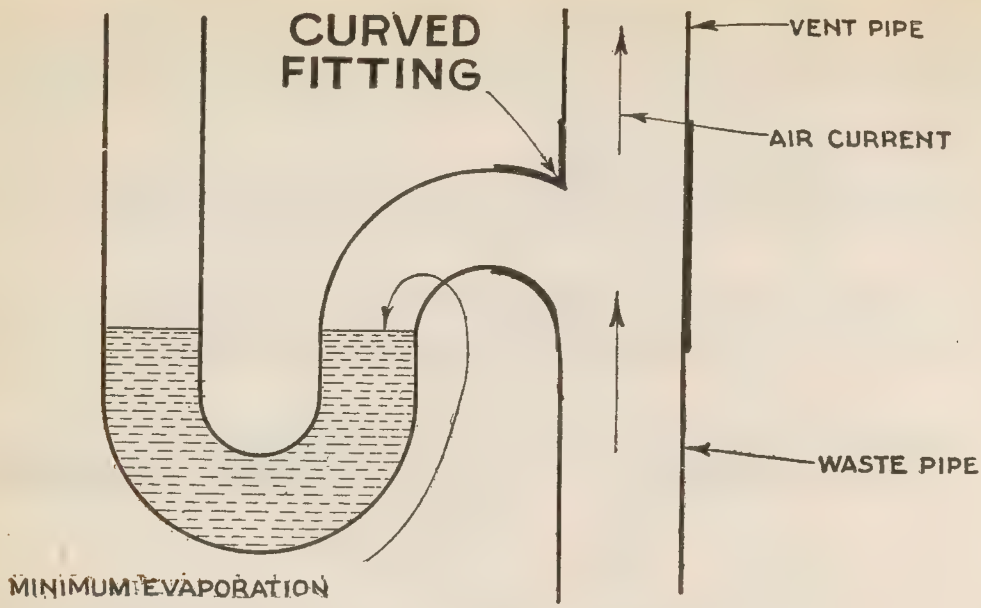


FIG. 7,102.—S trap vented by curved or sanitary T connection, the vent and waste pipes forming the same line. Since the trap water is remote from the vent connection there is less loss by evaporation than by crown venting. Note that the tendency of the air current is to flow up through waste pipe into vent pipe.

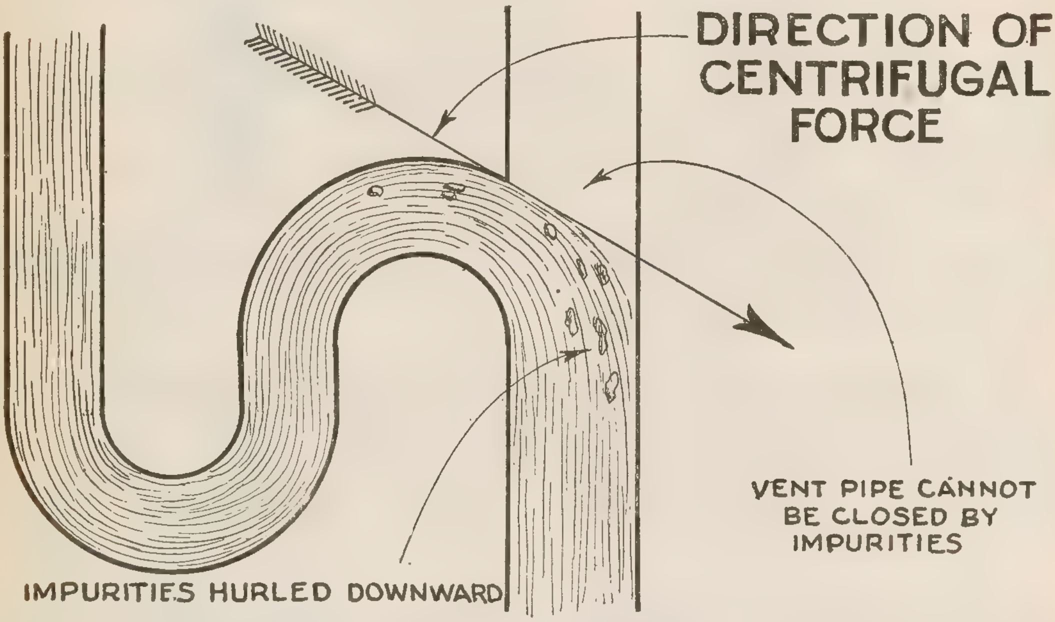


FIG. 7,103.—Operation of S trap with sanitary T vent connection showing that because of the downward curve of the T branch, centrifugal force acts downward at the vent connection causing the discharge to be directed into the waste pipe rather than into the vent pipe as in the case of a crown vent. ***It must be evident*** that the above vent arrangement is not subject to stoppage (as in figs. 7,096 to 7,099) and therefore should be used instead of a crown vent.

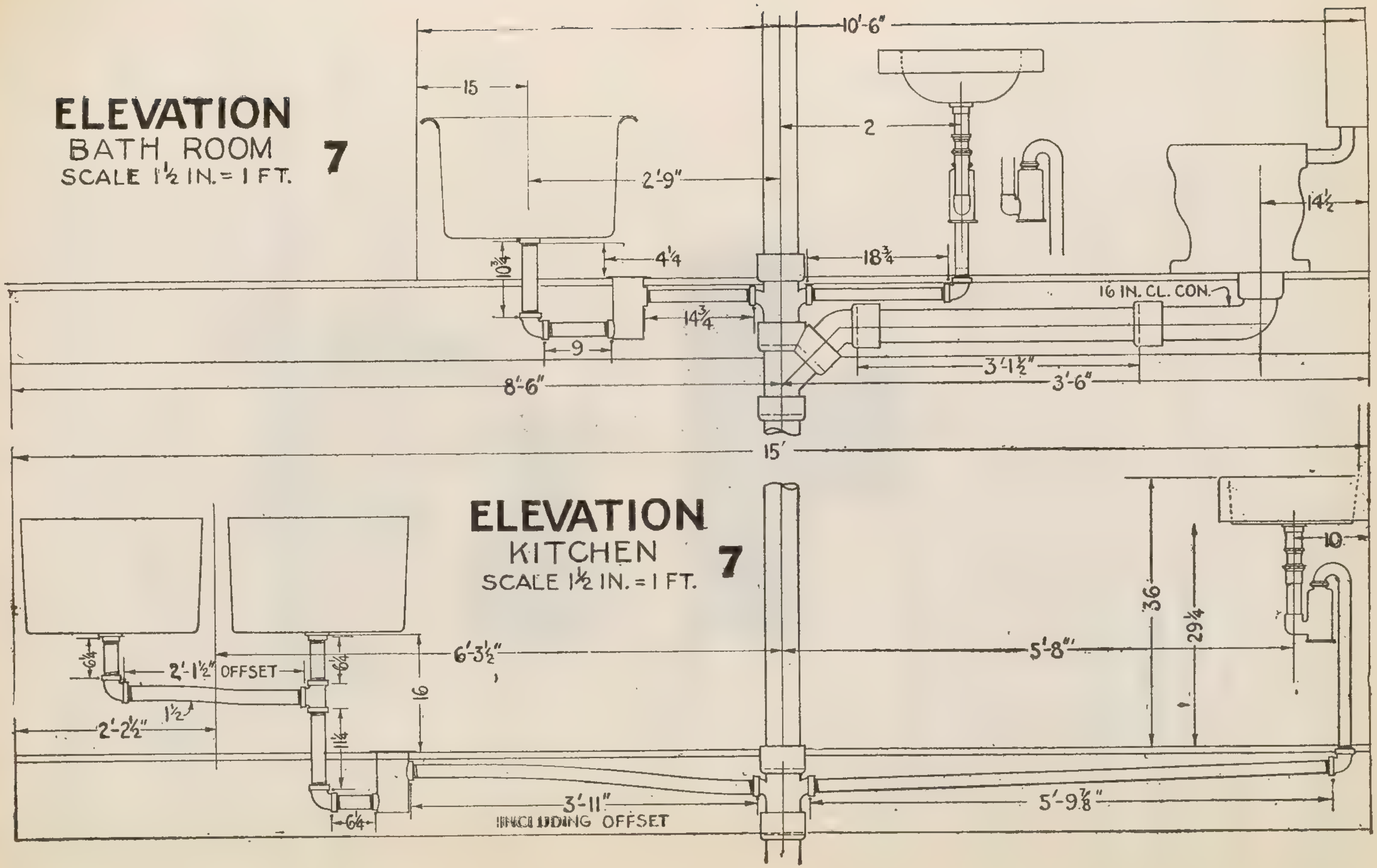
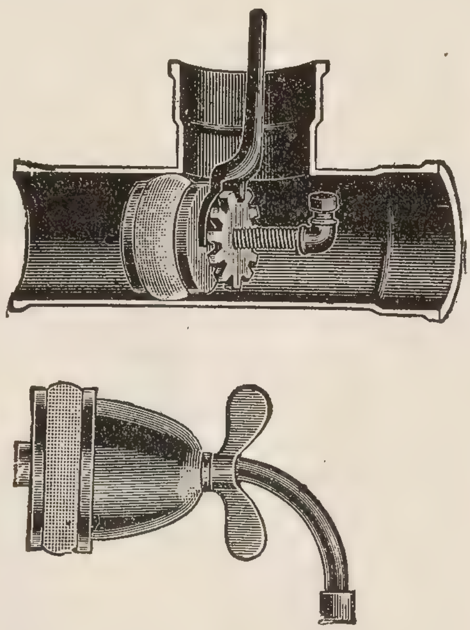


FIG. 7,104.—Roughing in for installation with ***unvented drum traps.***

The drum trap often simplifies ventilation problems, especially in awkward situations where it would be difficult to vent a fixture properly with pipe.

In good practice a drum trap serving a bath tub will be located in an accessible place where the clean out screw top may be conveniently reached.

This clean out should be preferably flush with the floor. To illustrate the use of the drum trap and the simplicity secured by dispensing with vent lines, the same installation of fixtures shown in fig. 6,942, is roughed in for unvented drum traps as shown in fig. 7,104. The installation of the water supply system is taken up in the chapter on pipe fitting.



FIGS. 7,105 and 7,106.—Fleck proving or testing plugs. Fig. 7,105, ratchet style; fig. 7,106, wing nut style.

Tests.—All the piping of any plumbing installation must be both water tight and air tight. There are several kinds of tests that should be made.

1. Water (hydrostatic).
2. Air.
3. Peppermint.
4. Smoke

Formerly the water test was applied after the completion of the roughing in work, but now, and especially on large installations it is applied progressively as the work proceeds to avoid the increased expense in case it be necessary to remove any defective parts, that is, to avoid extra work in taking out defective pipe and fittings, it is best to fill the pipe with water as installed. Defects of material and workmanship are then

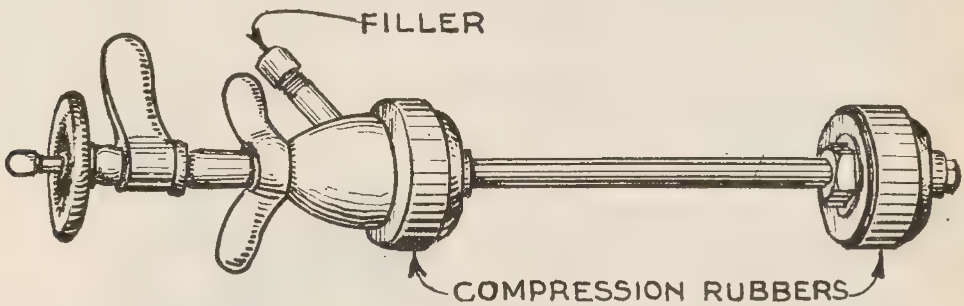


FIG. 7,107.—Fleck straight double testing plug.

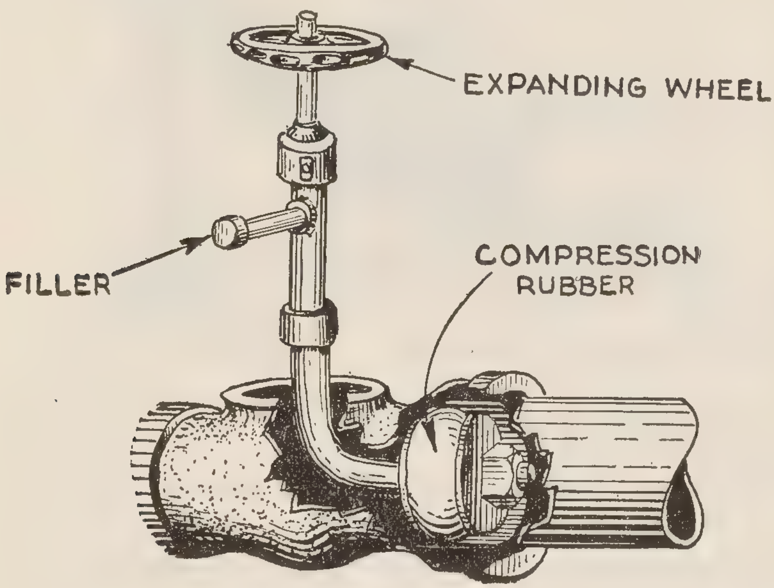


FIG. 7,108.—Fleck test tee proving plug.

brought to light at a time when they can be remedied at the least expense.

Earthen drains should be carefully tested for leakage before the trenches are filled.

Plug the low end of the line and fill with water. A pressure of at least 1 lb. per sq. in. should be applied. A leak, if not visible will be indicated by the water settling in the pipe and should be found and made tight. The water test should be applied to all the soil, waste and vent pipes in the building.

In making this test, plug the house drain when it passes out of the building, also the fresh air inlet and all other outlets up to the highest opening.

The kind of plugs used to close the openings are known as proving or testing plugs as shown in figs. 7,105 to 7,109. If the branch pipes be of lead, they are closed by soldering caps over the ends. Assuming that the outlets have been tightly closed by the plugs, if, when the pipes are filled

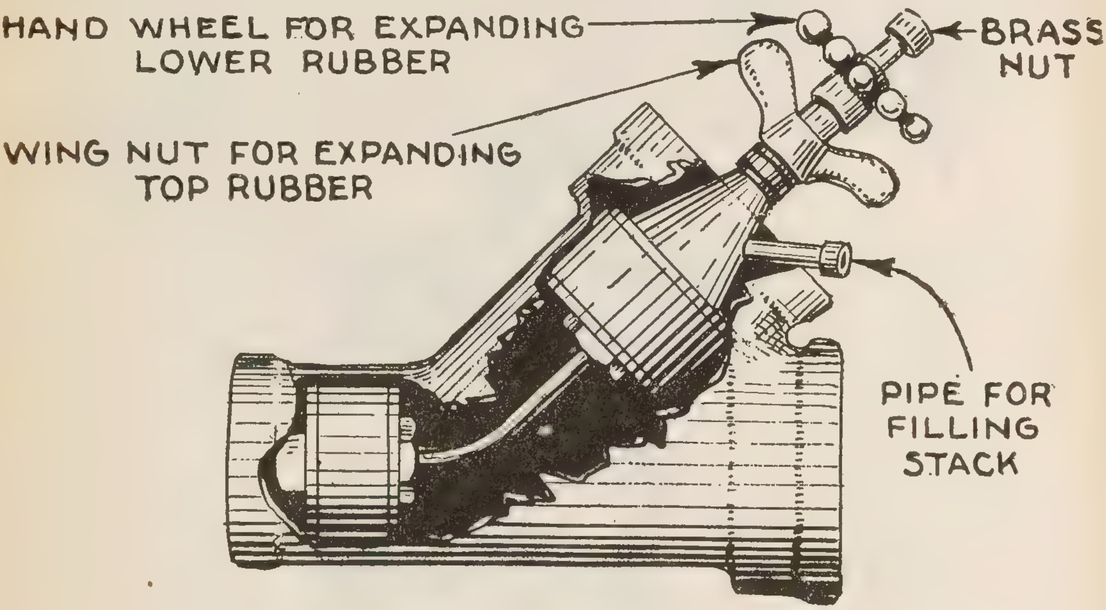


FIG. 7,109.—Fleck Y branch double testing plug.

with water, the water fall, it indicates a leak; if the water remain at the same level, the system is tight.

In looking for leaks first inspect all the plugged openings to see if they be tight.

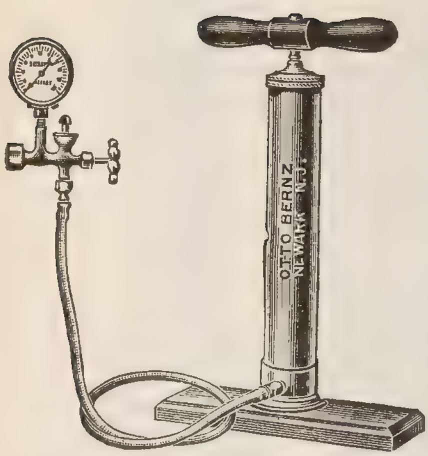
If the weather be too cold to apply the water test the air test may be substituted.

In making this test, after closing all the openings with testing plugs air is pumped into the system to a pressure of 10 lbs. per sq. in. as indicated in a mercury gauge rather than a spring gauge. The type apparatus used is shown in figs. 7,110 to 7,112. A leak is indicated by a fall in the level of the mercury column. To detect a leak apply soapy water with a brush; if there be a leak, bubbles will form.

It should be noted that the air test gives a practically uniform pressure over the entire system, whereas, in the water test, the pressure is greatest at the lowest level and least at the highest level. Moreover, caution should be used with the water test not to apply it where the height of the vertical pipes is so great as to produce pressures too great for the pipes.

After the fixtures and traps have been installed the peppermint, or the smoke test is applied as a final test.

In making the peppermint test all fixtures hould be set and the traps



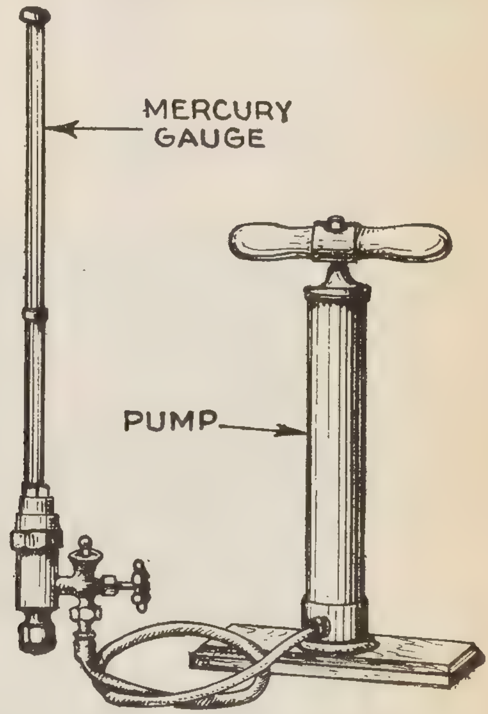


FIG. 7,110.—Bernz testing pump with air gauge, ether cock and hose.

FIG. 7,111.—Bernz testing pump with regular old style mercury column and hose. The mercury column is fitted with a glass tube which is guarded by a brass shield. This shield is graduated for the convenience of the user. This style mercury column must be emptied after each job.

properly filled with water. Two ounces of oil of peppermint should be poured down each pipe that projects through the roof for each five stories and basement in height of the building and one additional ounce for each additional five stories in height. The fresh air inlet should be closed before using the peppermint. After pouring the peppermint down the pipe it should be followed up with two gallons of hot water. The tops of the pipes should then be closed to prevent the odor of peppermint escaping.

To detect leaks, smell each joint of the system and if the odor of peppermint be detected it indicates a leak.

In making the smoke test, a machine called a smoke test machine is procured.

The traps are properly filled with water and all fixtures set. The opening at the fresh air inlet should be closed. The machine is generally connected to the fresh air inlet or to one of the extensions above the roof. Charcoal is placed in the machine and lighted, oily waste is placed on the

FIG. 7,112.—Fleck mercury gauge for indicating pressure in air pressure test on roughing in work.

coal and the smoke forced into the system until it issues from the extensions above the roof when they should be closed. The smoke is forced into the piping until the pressure equals 1 or $1\frac{1}{2}$ ins. of water. If the machine be applied to the extensions above the roof the smoke should be pumped in until it issues from the fresh air inlet when the fresh air inlet should be closed.

Leaks are detected by smell or if the smoke be dense enough it can be seen escaping. Smoke machine is shown in fig. 7,113. When the smoke

NOTE.—In preparing for *the peppermint test*, careful distinction should be made between *oil*, which is the essential oil, and the *essence*, which is a solution of a small portion of the essential oil in a large volume of alcohol and which is useless for the test.

test is made, or the air test, after fixtures are installed, the applied pressure should be about 1½ ins. of water.

If any of the traps blow through at a lower pressure than 1½ ins. they should be readjusted until they will hold that pressure. If that cannot be accomplished a better trap should be installed. After the pressure is put on the system closely watch the water gauge for several hours. If the water column fall, it indicates a leak.

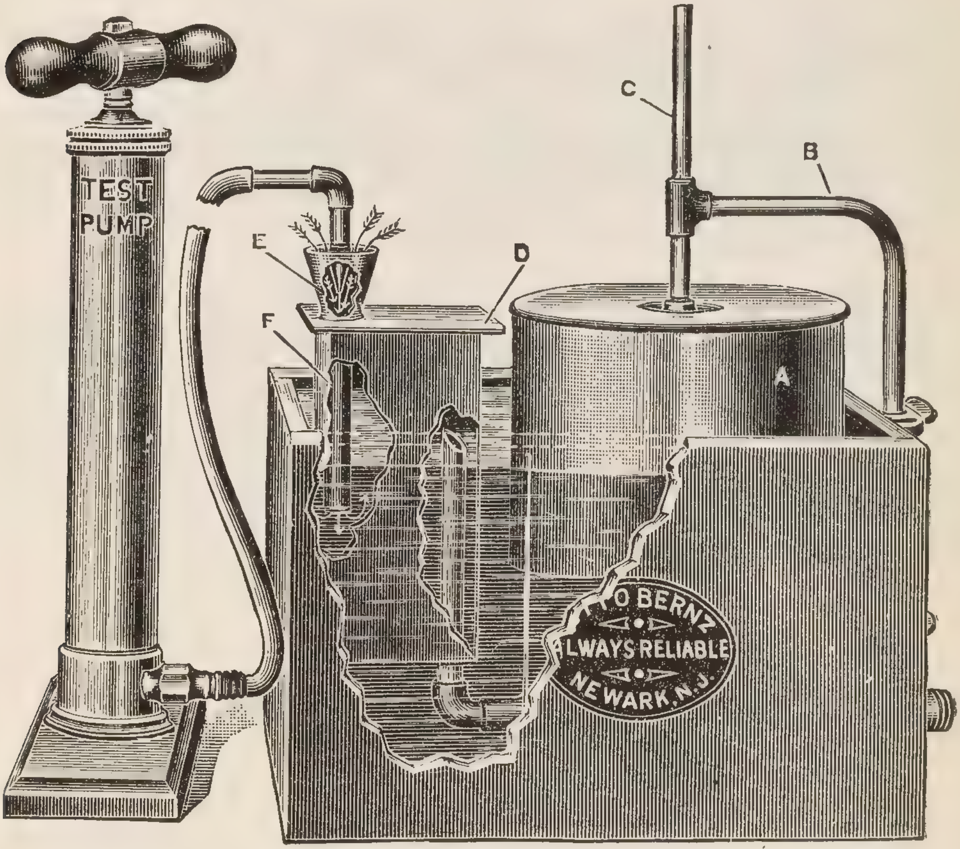


FIG. 7,113.—Bernz smoke testing machine. ***In operation,*** a small amount of oily waste is placed in the smoke chamber ignited and air blows through by the air pump.

NOTE.—***Testing in sections.***—It is sometimes necessary to test a drainage system in sections, so as not to delay the completion of other parts of the work. When testing in sections, all parts of the drainage system should be subjected to at least one test under a hydrostatic head of ten feet or more. When a house drain is installed and is to be covered it can be tested by first extending all branches above the cellar floor level and plugging all outlets but one, into which is calked two lengths of pipe, then filling the system with water until it almost overflows the top length. When the soil and waste stacks are afterwards installed and tested, the entire system is filled with water, thus subjecting all parts to at least one test.

NOTE.—***When soil, waste and vent stacks are installed first,*** they should be extended down below the basement ceiling, and they may then be tested separately or

collectively by connecting them together with small sized wrought pipe. After the house drain is installed, the system should then be filled with water to at least ten feet above the highest untested joint in the vertical stacks.

NOTE.—***A good plan to follow*** where testing drainage systems in buildings from four to eight stories in height, is to fill and test the work as soon as it is installed. By so doing, any serious leaks in the pipes are discovered, and if necessary to remove a defective section it can be done with much less effort than after the stacks are through the roof and lead roughing in place. Furthermore, workmen are more careful when they have to test their own work immediately after installing it.

NOTE.—***The drainage system*** in extremely tall buildings is tested in sections, so that no part of the system will be subjected to excessive pressure. This is done by leaving out a short connection of pipe between the several sections. Then, after the several sections have been tested separately, beginning at the top, they are all connected together. When the top section has been connected to the one next below it, the stack is filled with water to a height of 10 feet above the connection. This double section of pipe, after being emptied, is then connected to the section next below it, and the stack filled with water to 10 feet above the connection, as in the former case. This operation is repeated until all sections of the drainage system have been connected, and the joints of all connections subjected to a test.

NOTE.—***In warm climates*** the air test is seldom applied, chiefly on account of the difficulty in locating leaks. When applying an air test the first place to examine for leaks is around the testing apparatus. This being tight, the testing plugs should next be examined and made tight, after which the house drain, and then the soil waste and vent stacks should be examined. If the system leak badly, dash a bucketful of soap suds on the top of each stack in turn, and watch for bubbles as the soap suds follow down the stack. When the large leaks are located and made tight, the smaller ones can be found by daubing soap suds on the pipes and joints with a large brush. The pressure must be maintained within the system during the search for leaks, otherwise bubbles will not form when suds are applied to the leak.

CHAPTER 118

Valves, Faucets, Cocks and Other Accessories

For the control of the water supply and for making proper connections between the fixtures and the waste and soil lines, various accessories such as valves, traps, fine thread fittings, gaskets, etc., are required. Those ordinarily used by the plumber in the installation of the fixtures are:

1. With respect to the control of the water supply
   a. Valves.
   b. Faucets.
   c. Cocks.
2. With respect to the joints and connections.
   a. Washers.
   b. Gaskets.
   c. Packings.

etc.

It is not the purpose of the author to present here a manufacturer's catalogue of plumbing goods, but rather to give helpful information to the student of plumbing so that he will understand the working of the various devices and with this knowledge, will be able to intelligently install the various fixtures and their accessories.

Valves.—By definition, broadly speaking, a valve is *a lid or cover to an aperture, so formed as to open a communication in*

one direction, and close it in the other by lifting, turning or sliding the cover.

Exclusive of faucets and cocks, which are in fact special forms of valves identified with plumbing installations, there is a great multiplicity of types of valves designed to meet every conceivable condition of service.

All valves may be divided into two general classes:

1. Non-automatic.
2. Automatic.

The non-automatic class embraces those which are operated by hand. Automatic valves are controlled by some condition of service operating to open or close them.

An example of automatic valves is the valves of a pump, being opened at the beginning of the suction stroke by the vacuum created, and closed at the beginning of the power stroke by pressure, due to the resistance pumped against, such as a head of water.

Grouped according to the above divisions the valves ordinarily met with in plumbing practice are:

1. Non-automatic valves.
   a. Globe.
   b. Angle.
   c. Three way.
   d. Stop.
   e. Needle.
   f. Gate.
   g. Flushing.
   h. Blow off.
   i. Waste.
2. Automatic valves.
   a. Check.
   b. Float (closet tank).
   c. Float (house tank).
   d. Intermittent.
   e. Radiator (air).
   f. Flushing.

g. Pressure reducing.
h. Relief.
i. Safety.

Globe Valve.—About the most well known type of valve is the globe valve, which is largely used in most piping systems for water, air and steam.

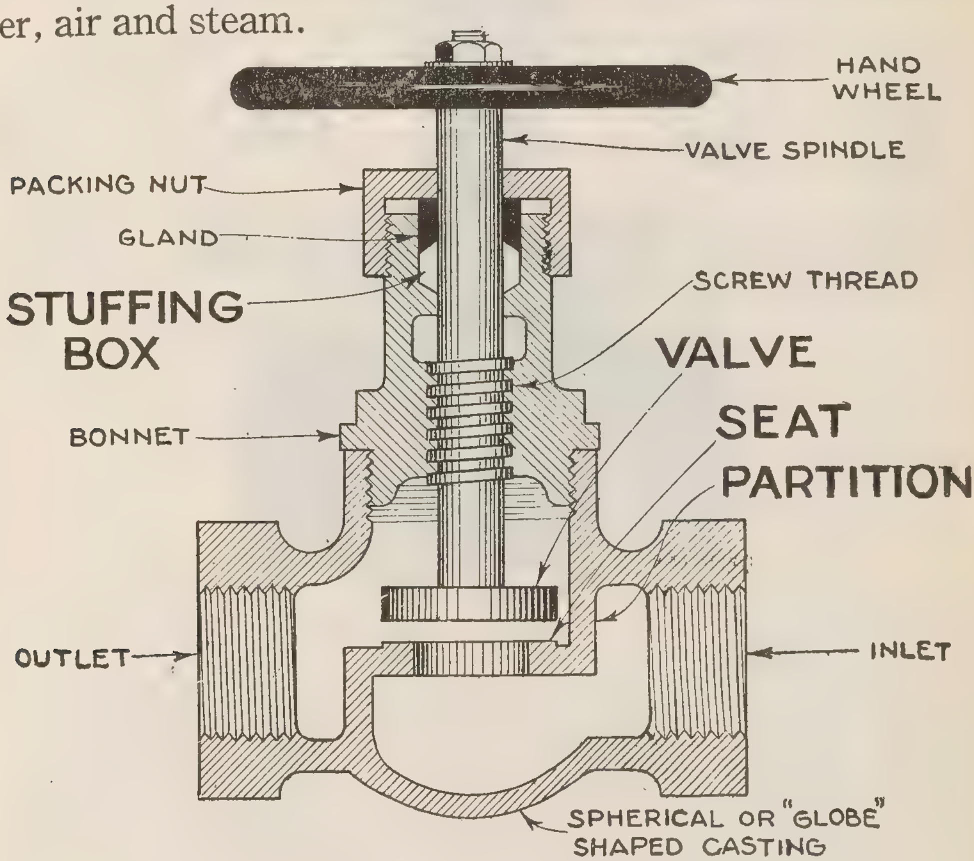


Fig. 7,114.—Globe valve. A commonly used type of valve which takes its name from the globe shaped casting forming the body of the valve. ***It should be noted*** that whereas the entire assemblage of parts here shown is ordinarily called a valve, the term valve, strictly speaking and in accordance with the definition, means the disc at the end of the valve spindle. This disc is the "lid or cover" mentioned in the definition.

This type of valve is designed to be placed in the run of a pipe line, the inlet and outlet line and has female threads.

As shown in the elementary drawing, fig. 7,114 a spherical casting has an interior partition which shuts off the inlet from the outlet except through a circular opening in the seat. Screwed into an opening in the top of the

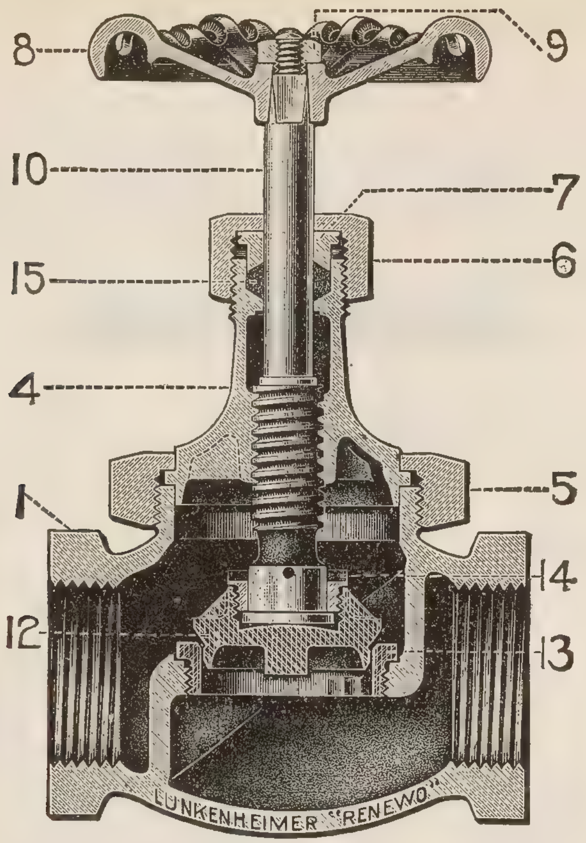
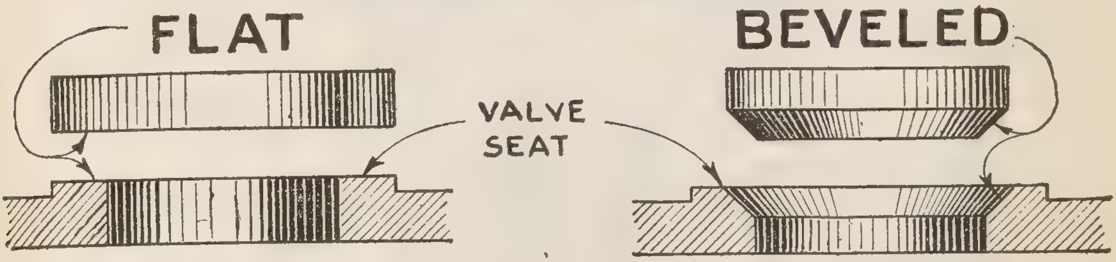


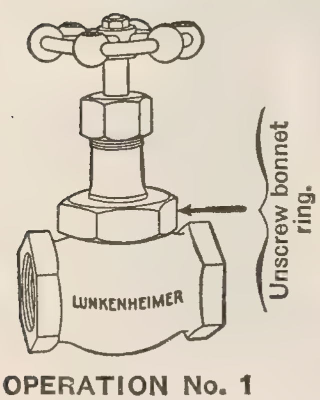
FIG. 7,115.—Lunkenheimer "Renewo" globe valve ***with beveled seat. Parts*** 1, body; 4, bonnet; 5, bonnet nut; 6, packing nut; 7, gland; 8, hand wheel; 9, wheel lock nut; 10, valve spindle; 12, disc valve; 13, renewable nickel seat; 14, disc lock nut; 15, packing. ***In construction,*** on the under side of the disc projects an annular lip, which fits just inside the seat ring when the disc approaches the seat. It is this annular extension on the disc which causes the automatic cleaning of the seat every time the valve is closed, and so prevents the catching of any scale or sediment between the disc and seat surfaces. As the disc is lowered and the lip enters the seat ring, the current of steam is deflected upward away from the seat surface, and this minimizes the danger of "wire-drawing" across the face of the seat. At the moment just before the two surfaces meet, a thin but powerful jet of steam is turned directly across the face of the seat, thereby blowing away all pieces of scale or other solids whose presence would prevent a perfect closing of the valve. On opening this valve the peculiar seat and disc construction makes it impossible, under any conditions, for the water or steam to pass through suddenly. It can flow past the lip and over the seat only in a gradually increasing stream. This will do much to avert destructive water-hammer, which is caused by a sudden inrush of steam. Up to 1½ ins. inclusive the valves are furnished with hexagon bonnet rings; above 1½ ins. round slotted rings are supplied. Stuffing boxes are provided with gland follower on sizes above ½ in. ***To regrind the seat bearings,*** unscrew the union ring which holds the hub to the body, and remove the trimmings. Place a little powdered glass or sand, and soap or oil on the disc and insert a wire or pin through the slot in the disc lock-nut and hole in stem, which will prevent the disc turning on the stem. Replace the trimmings in the valve body and regrind, leaving the union ring unscrewed so that the hub rotates in the body and acts as a guide for the stem while regrinding. After a new bearing surface is made, care should be taken to wipe the abrasive material off both the seat and disc, and particularly to remove the pin previously placed in the disc lock nut and stem.

casting is a plug having a stuffing box and a threaded sleeve in which the valve spindle works.

On the lower end of this spindle is the valve proper and on the other end a hand wheel. The valve is closed by turning the hand wheel clockwise which lowers the spindle and valve until it presses firmly and evenly on the valve seat thus closing communication between the inlet and outlet. By



FIGS. 7,116 and 7,117.—Flat and beveled valves and valve seats. For equal discharge capacity a beveled valve must be opened more than a flat valve.



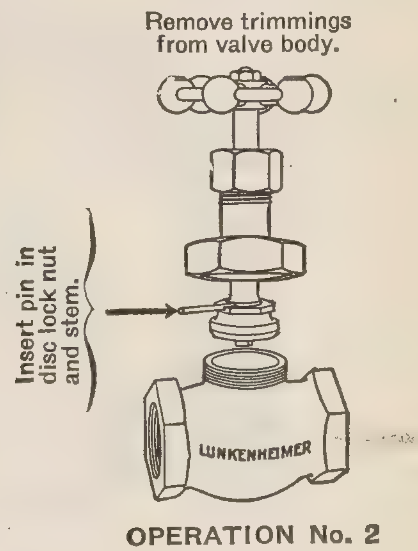


FIG. 7,118.—Regrinding globe valve. ***Operation 1:*** Unscrew the bonnet ring.

FIG. 7,119.—Regrinding globe valve. ***Operation 2:*** Remove the trimmings from the body and insert a pin or wire through the groove in the disc lock nut and the drill hole in the stem. This step is necessary to prevent the disc turning on the stem during regrinding.

turning the hand wheel in the opposite direction (counter clockwise) the valve is opened.

The seat and valve may have their contact surfaces either flat or beveled as shown in figs. 7,116 and 7,117.

The valve disc may be of metal or fibre. Fibre seat should be interchangeable. A globe valve will remain tight longer than a gate valve.

Objections are that unless properly designed, the opening through seat

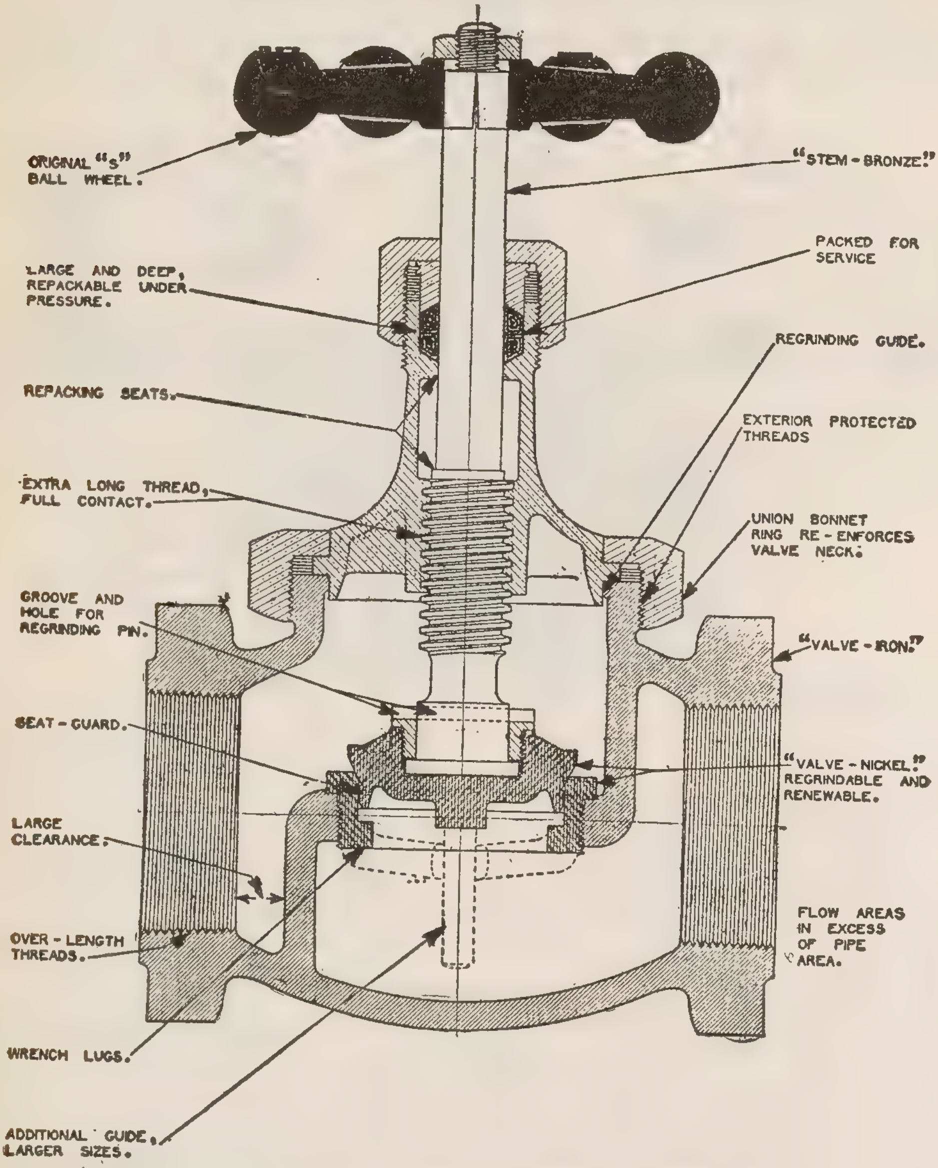
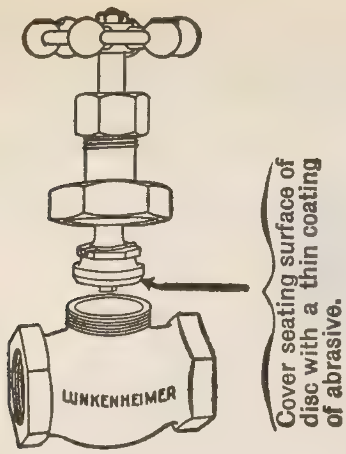
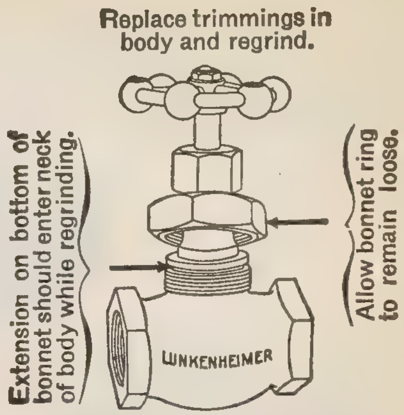


FIG. 7,120.—Lunkenheimer "Ferrenewo" globe valve made in sizes ¼ to 2 ins.

NOTE.—The ratio of the hydraulic test pressure ratings to the maximum working pressure ratings—over 3½ to 1—presents striking evidence of a consistent recognition of the service factor which a strictly serviceable line of valves should possess regardless of the size of the valve or the pressure to which it is subjected. The actual safety factor of a valve is the ratio of the rupture pressure to the working pressure and can only be determined by a break test, but it is evident that a valve structure which will withstand a 3½ to 1 internal test without distortion possesses a sufficient margin to give assurance of dependable performance.



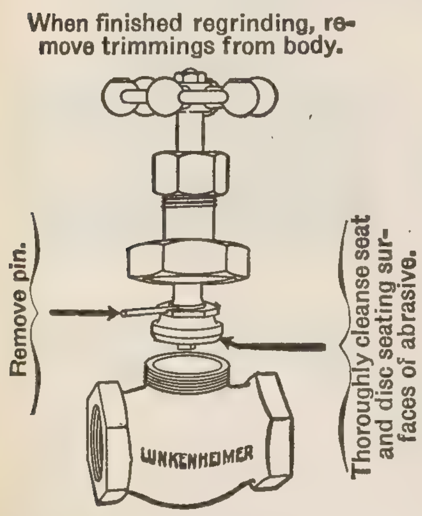
OPERATION No. 3



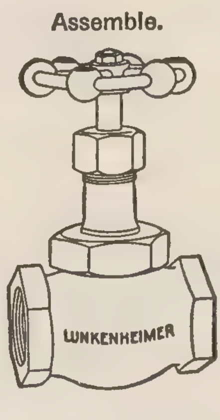
OPERATION No. 4

FIG. 7,121.—Regrinding globe valve. ***Operation 3:*** Cover the seating surface of the disc with a thin coating of Lunkenheimer regrinding compound or other suitable abrasive.

FIG. 7,122.—Regrinding globe valve. ***Operation 4:*** To regrind, the trimmings should be replaced in the body with the disc resting upon the seat and with the projection on the bottom within the neck of the body, but with the bottom of the flange on the bonnet separated from the top of the neck by from $\frac{1}{16}$ to $\frac{1}{8}$ of an inch. The proper relative position of the bonnet and disc may be secured by holding the former stationary and turning the spindle the necessary distance. The union ring should rest loosely on the bonnet and entirely disconnected from the threads on the neck of the body. The disc should then be rotated back and forth on the seat by turning the handwheel to the right and left. Best results will be obtained by occasionally changing the position of the disc. Remove the trimmings and thoroughly cleanse the seating surfaces. Replace trimmings and repeat the grinding action, using soap or oil instead of abrasive.



OPERATION No. 5



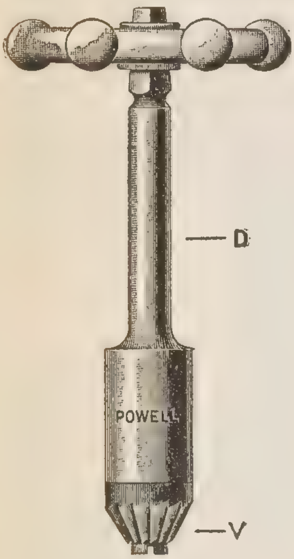
OPERATION No. 6

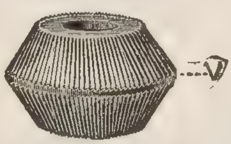
FIG. 7,124. — Regrinding globe valve. ***Operation 6:*** Assemble trimmings in the body, observing particularly that the bottom of the flange on the bonnet is resting on the top of the body neck, before screwing down the union ring. This precaution will avoid danger of springing the disc or seat or bending the stem.

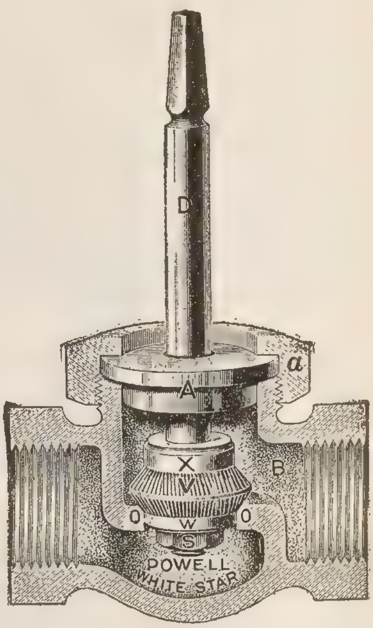
FIG. 7,123.—Regrinding globe valve. ***Operation 5:*** Remove trimmings and extract the pin previously inserted to prevent the disc turning on the stem. Bring the disc as close as possible to the bonnet by holding the latter stationary and revolving the spindle.

of the valve is not the full area of the pipe size; this and the contorted passages offer considerable resistance to flow. A serious objection on water lines that must be drained in freezing weather is that it is impossible to drain the water from a horizontal line when the valve spindle is in an upright

FIG. 7,125.—Crane renewable disc; made in sizes ⅛ to 12 ins. in diameter. These discs are made of compositions, each particularly adapted to the service for which it is recommended. The steam disc is for saturated steam up to 150 lbs. pressure. The hot water disc is somewhat softer than the steam disc and is adapted to hot water of temperature not over 225° Fahr. The cold water disc is adapted also to compressed air, but should not be used on hot water or steam lines. It is the custom of manufacturers to furnish steam discs unless otherwise ordered.



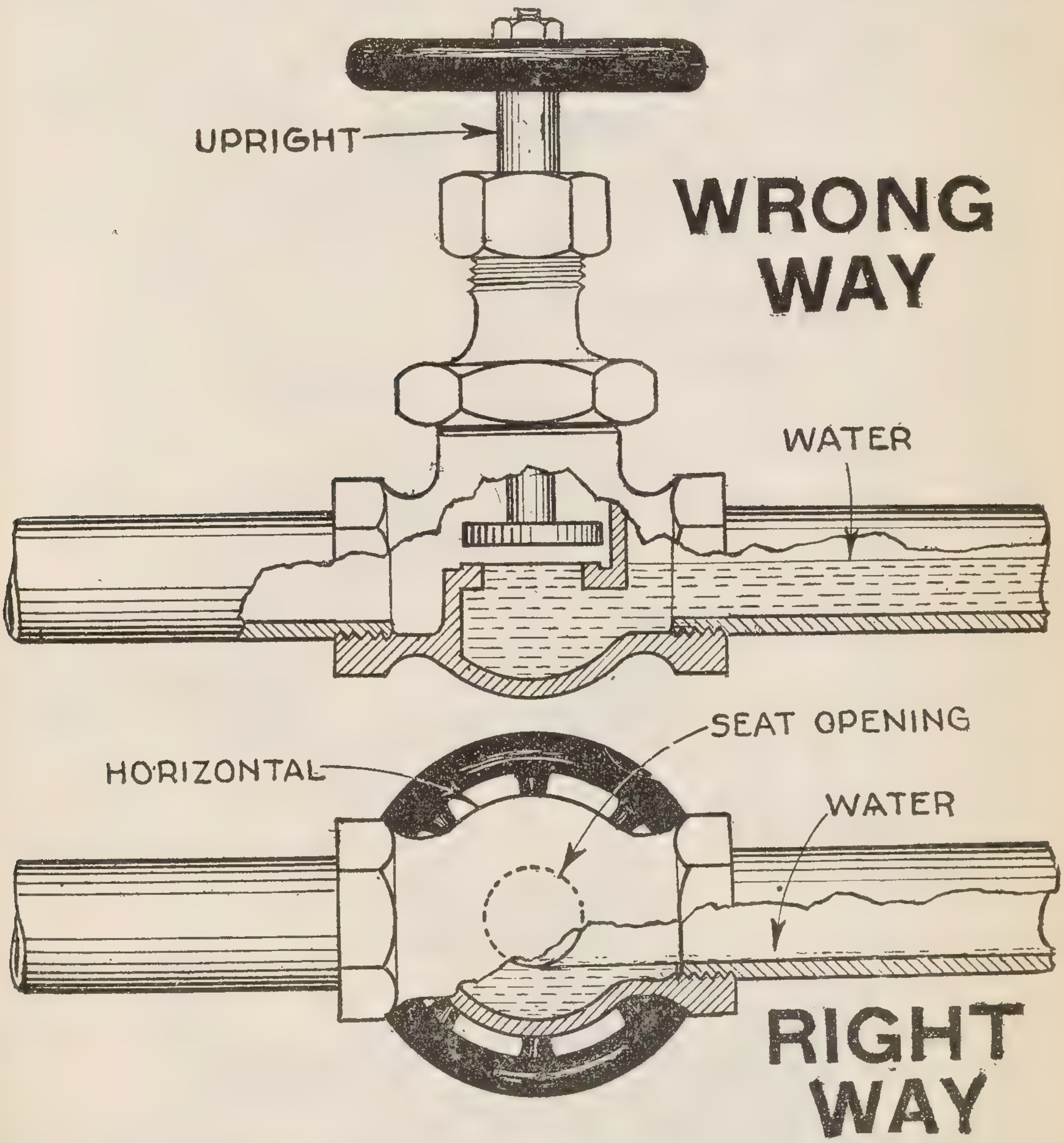




FIGS. 7,126 to 7,128.—Powell valve reseating tool. Fig. 7,126, style of tool for small size valves (¼, ⅜ and ½ in.); valve wheel in position on stem to reface valve; fig. 7,127, double faced milling cutter for ¾ to 3 in. valves; fig. 7,128, tool with double faced milling cutter in position ready for regrinding a globe valve. ***Operation:*** Unscrew the trimmings from the body of the valve, release the wheel handle, remove the hexagonal union nut *a*, drop the reseating tool into the valve body and clamp it firmly in position with hexagonal union valve nut a, and by means of a bit stock or the valve wheel handle, turn arbor D, to the right and the refacing of the seat is easily accomplished. Don't use too much muscle in operation, as the miller cuts rapidly. Ease up on the movement just before stopping. Don't face off the seat more than is necessary to get a clean, smooth surface. After removing the tool be sure to regrind the disc and seat. The parts are: D, steel reseating arbor; A W, guide collars; X, shoulder collar; V, double faced milling cutter; S, miller lock nut; a, hexagonal union valve nut holding the re-seating tool firmly while refacing; O O, seat in body of valve.

position. Hence in piping up such lines always have the spindle horizontal. Figs. 7,129 and 7,130 explain this.

Angle Valve.—This is virtually *a globe valve with inlet and outlet at* 90° *to each other* as shown in fig. 7,131. Evidently such



FIGS. 7,129 and 7,130.—***Wrong way*** and ***right way*** to place globe valves on horizontal lines. ***Evidently*** when placed in upright position as in fig. 7,129, considerable water will remain in the pipe line subject to freezing. When placed in horizontal position as in fig. 7,130, most of this water will drain through the seat opening with less danger of damage by freezing.

valve can serve the double purpose of controlling the flow and changing the direction of the pipe line thus doing away with the use of an elbow. Angle valves as well as globe valves are made with metal seats and with soft seats; the latter should be used on water lines. Fig. 7,131 shows the general features of an angle valve.

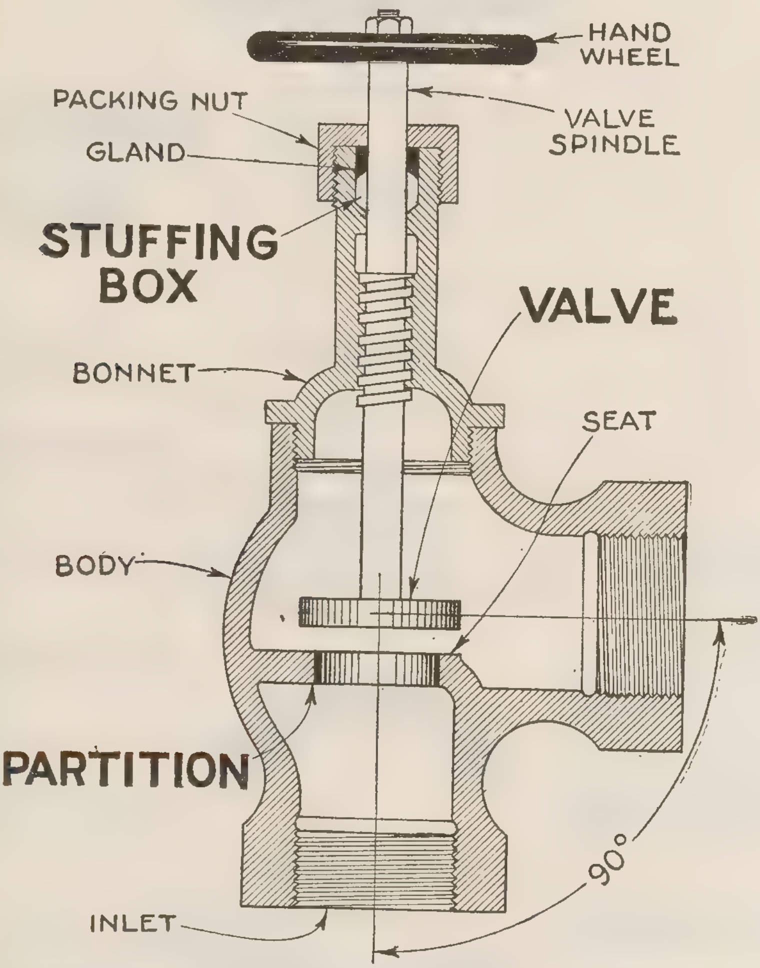
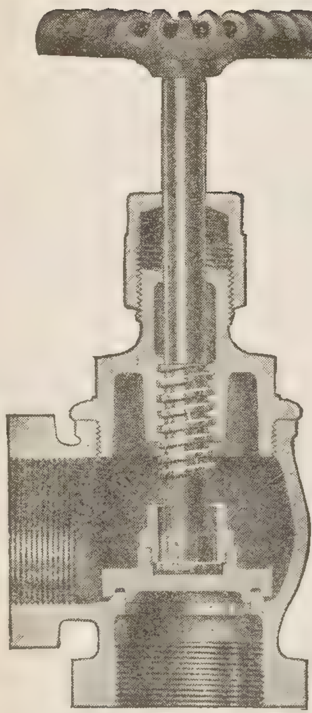
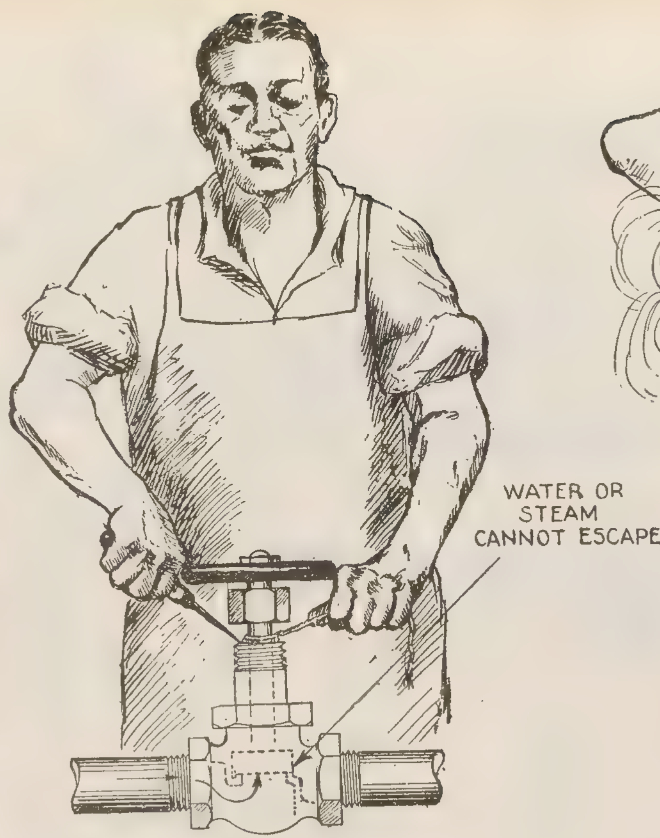


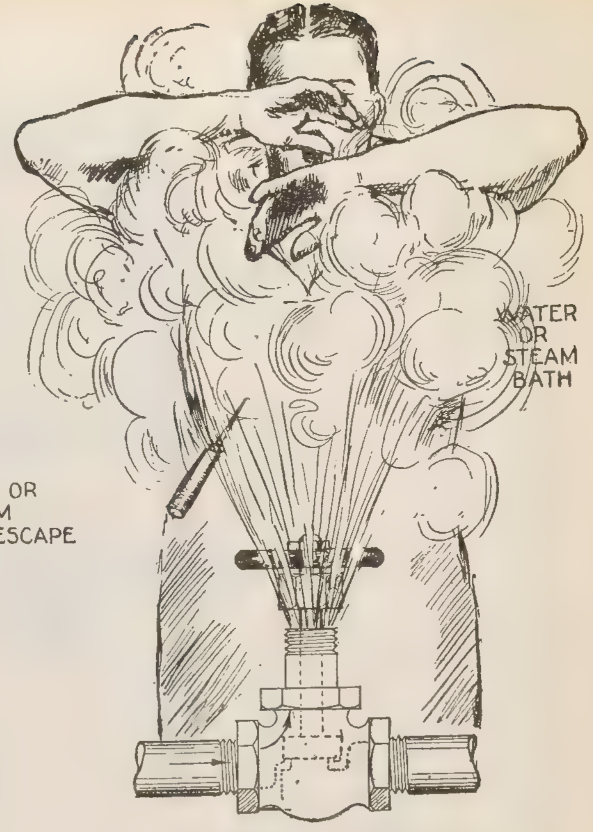
Fig. 7,131.—Angle valve. A form of globe valve with inlet and outlet at 90°. Angle valves are used where it is desired to control and change the direction of flow.

Right and Wrong Way To Place Globe Type Valves.—In connecting a globe type valve it is important to place it in the line so that its inlet side will carry the pressure when the valve





RIGHT WAY



WRONG WAY

FIG. 7,132.—Crane extra heavy angle valve ***with grooved disc.*** The particular feature of this valve is the construction of the disc and seat adapting it for use as blow off on boiler, on skimming lines and for all cases where it is desirable to blow off dirty water containing grit or sediment under pressure.

FIGS. 7,133 and 7,134.—***Right way and wrong way*** to connect a globe type valve in pipe line, showing disastrous result of attempting to repack a wrongly connected valve. In the illustrations the partition and disc are shown in dotted lines from which the proper position of the valve is clearly seen.

is closed, otherwise it will be impossible to repack the stuffing box while the line is under pressure, the result of attempting to repack a wrongly connected valve being shown in fig. 7,134. Accordingly, carefully distinguish which is the inlet side of the valve as shown in fig. 7,114.

Three Way or So Called Cross Valve.—The essentials of the

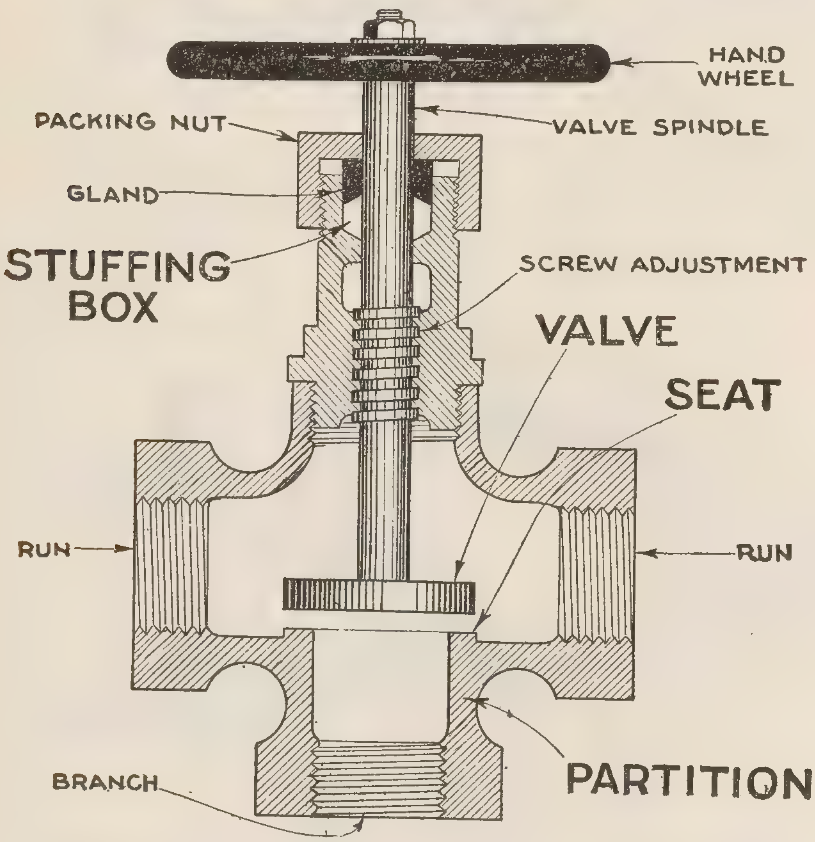


FIG. 7,135.—Three way o. so-called cross valve. Used to control the flow to or from a branch line at tne junction of a branch and main line. *It is virtually* a globe valve having its seat located at the bottom of the body and the passage through the seat connected with a third opening at right angles to the other two openings.

erroneously called cross valve are shown in fig. 7,135. This type of globe valve is used where it is desired to control the flow at the junction of a main line and a branch.

Evidently a three way valve, considered with the disc

removed is the equivalent of a T pipe fitting and in no way could it be considered as the equivalent of a cross, hence the error of calling it a cross valve.

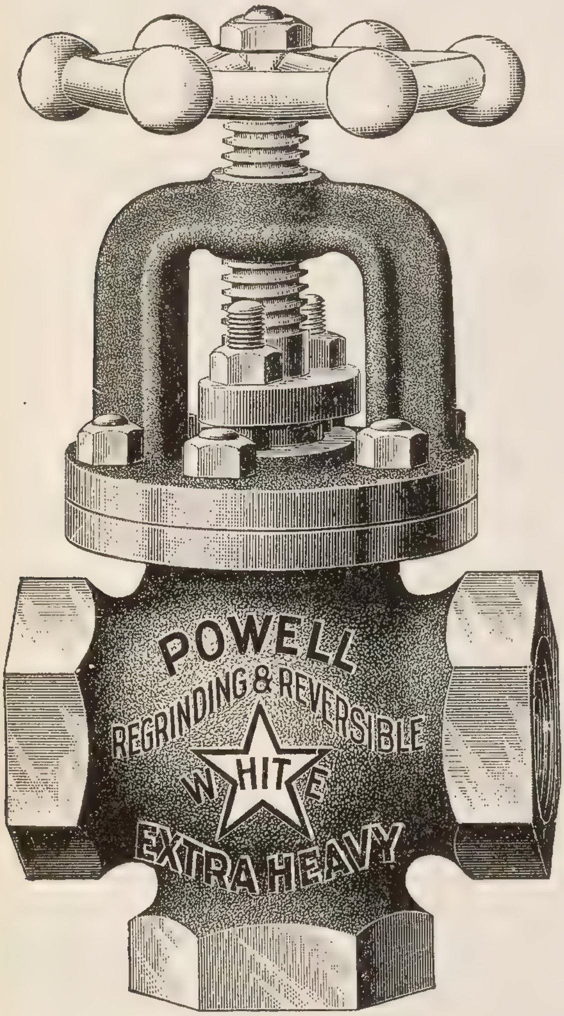


FIG. 7,136—Three way outside yoke valve.

In cases where the branch is the inlet, the valve can be repacked while under pressure but unfortunately the branch must frequently be made the outlet and in this case the valve cannot be repacked while under pressure.

The operation of regrinding is performed in the same way as for a globe valve.

The external appearance of a three way valve is shown in fig. 7,136.

Stop Valve.—The term stop valve is commonly and erroneously applied to all hand control valves, but strictly speaking a stop valve is a *non-return valve*, that is, it is virtually a check valve with a hand wheel and screw stem which acts only to close the valve, as shown in fig. 7,137.

When the hand wheel is turned to open position, the opening of the valve will depend upon the direction of pressure just as in the case of an ordinary check valve.

A non-return or stop valve is an exact mechanical equivalent of the

electrical discriminating cut out or reverse current circuit breaker and electrically speaking it may be called a *discriminating stop* or *reverse flow shut off*.

A stop valve is placed on the main steam outlet of each boiler of a battery of boilers, to prevent inflow of steam in case of accident or shut down for cleaning or repairs of one or more of the boilers.

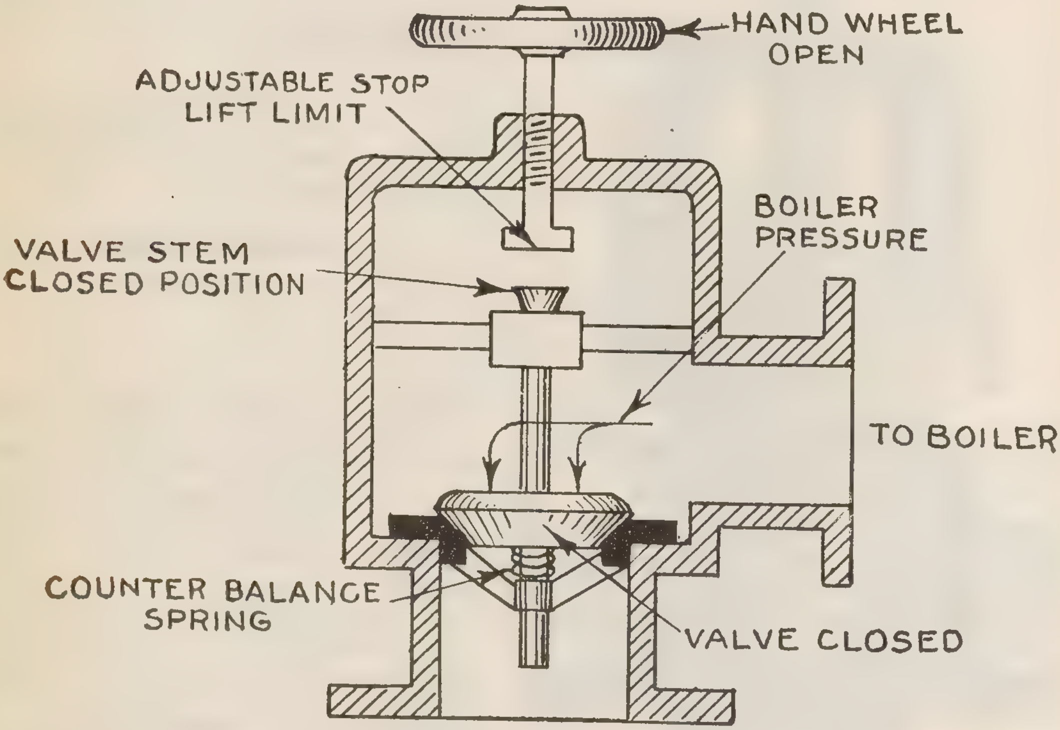
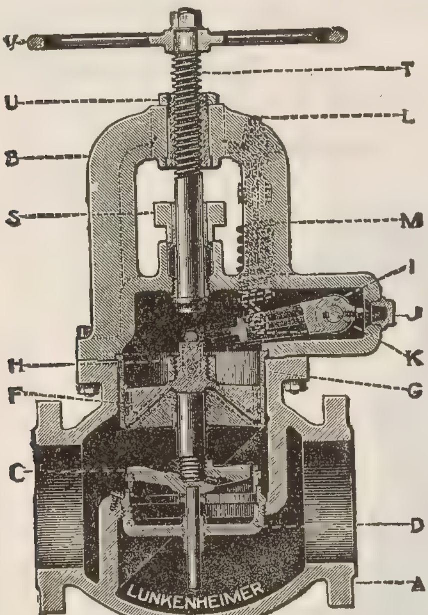


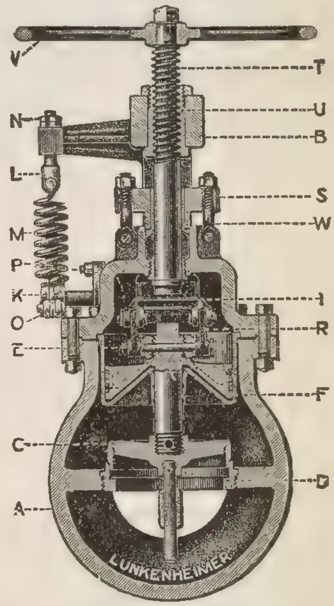
FIG. 7,137.—Stop or non-return valve. A form of check valve which can be opened or closed by hand control when the pressure in the boiler is *greater* than that in the line, but cannot be opened when the pressure *within* the boiler is *less* than that in the line. The counterbalance spring slightly overbalances, the weight of the valve and tends to hold the valve open, thus preventing movement of the valve with every slight fluctuation of pressure.

The importance of stop valves for use on a battery of boilers is universally acknowledged, and in some countries their installation is compulsory. It is evident that should a tube be blown out or a fitting ruptured in one of the boilers of a battery, the steam from the other boilers would rush into the header and discharge into the disabled one. An ordinary valve would here be inadequate, as considerable time would necessarily be consumed in reaching and closing the valve, and a certain amount of danger must be

anticipated. Where a stop valve is used, a slight reduction of pressure in the damaged boiler will cause the valve to act and isolate it from the others in the battery, preventing damage and possible injury or loss of life.

A stop valve will prevent steam being turned into a boiler which has been cut out for cleaning or repairs, as it can not be opened by hand when pressure is on the header side. It can, however, be closed when desired.





IGS. 7,138 and 7,139.—Lukenheimer non-return stop valve with outside spring and lever mechanism. Fig. 7,138, vertical section parallel to pipe; fig. 7,139, vertical section at right angles to pipe. The outside spring and lever is provided to effect a slight counterbalancing effect to hold the valve open, this being necessary in order to counteract the influences within the valve or line which tend to actuate the disc with every slight fluctuation of pressure. These fluctuations, usually caused by the engine, are frequently met with in steam lines, and unless some means be applied for counteracting these pulsations, the disc will be kept in continual motion. Where the fluctuations of pressure do not exist, and the flow of steam is steady, the use of the exterior spring and lever mechanism is not necessary. ***In adjusting*** the spring, the valve should be connected and tried, without the spring under tension. If, however, when steam is turned on, a pulsating condition develop, which can easily be detected by observing the movement of the spindle L, the regulating nuts N, should then be adjusted, gradually placing the spring under tension, until the rapid movement of the spindle L, is stopped. The adjustment of the nuts tends to lift the disc from its seat as it places the spring under tension, causing it to pull upon the lever O. This lever is keyed to the shaft K, which shaft enters the valve through the stuffing box P. Attached to the shaft O, is the forked arms I, to which are pivoted the links R, which, in turn, are loosely connected to the piston F. When the spring is under tension, the disc is raised from its seat and cannot close until the steam pressure above the disc exceeds that under it. This difference in pressure, which is governed by the tension on the spring, is never more than five pounds. When the valve is properly set to overcome the tendency of pulsation, the disc remains practically in equilibrium until there is a reduction in pressure on the inlet side, when it will instantly close.

The valve can be connected in either a horizontal or vertical position.

Needle Valve—This is a form of globe valve *used where only a very small amount of flow and close regulation are desired.*

In place of a disc the pointed end of the spindle forms the valve proper seating on a beveled seat of the same taper. The standard angle of seat is 30° to the spindle axis. Fig. 7,140 shows the construction of a needle valve.

Gate Valve.—In this type of valve *the flow is controlled by a sliding gate* operated by means of a spindle with screw to move

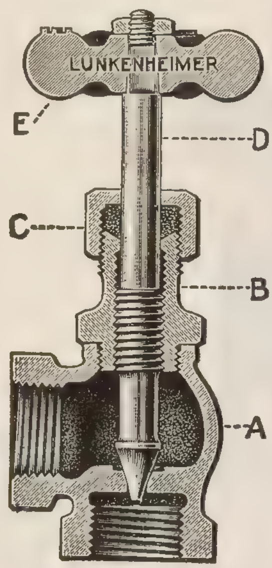


Fig. 7,140.—Lunkenheimer needle valve. Valves with steel stem are suggested for service demanding rather limited seat openings.

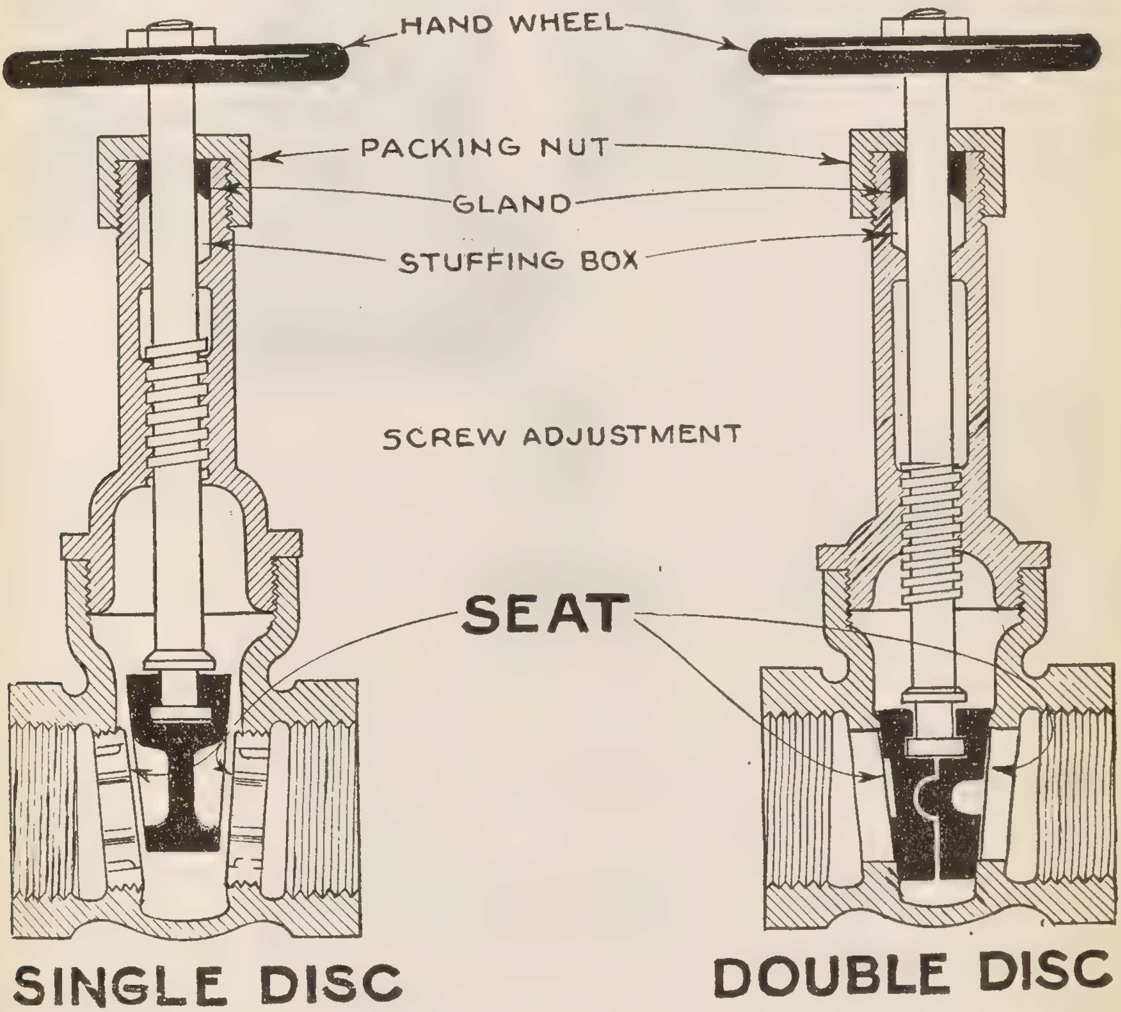
the gate in opening and closing. The special feature of the valve is that when opened it gives a full and unrestricted passage through the valve, there being no tortuous bends as in the case of globe type valves.

There are two types of gate valves, considered with respect to the "gate" or disc.

1. Single disc.
2. Double disc.

The essentials of the two forms are shown in figs. 7,141 and 7,142.

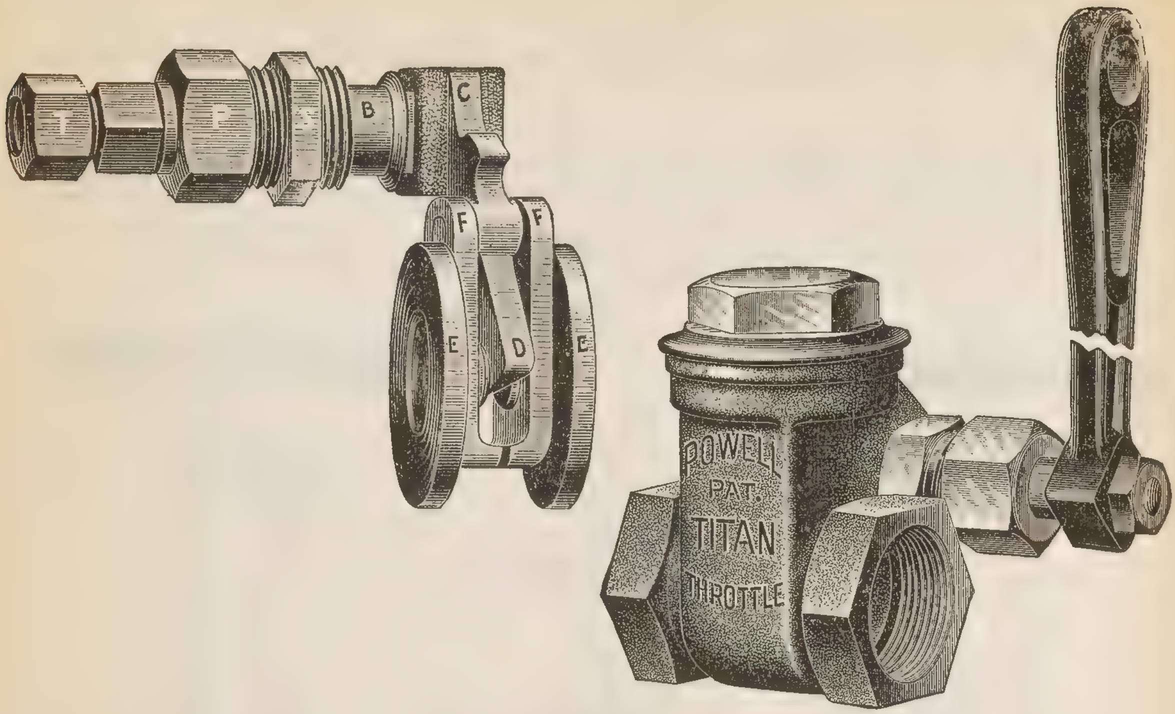
Each is operated by raising or lowering the *disc*. When closed the two faces of the disc are tightly pressed (by wedge action) against the seats thus affecting a double seal. It will be noted in figs. 7,141 and 7,142 that there are two seats for both the single and double disc valves.



FIGS. 7,141 and 7,142.—Single disc and double disc forms of gate valve.

The ordinary form of gate valve *should be used on lines requiring no throttling.*

Where continual adjustment is required a globe valve should be used.



FIGS. 7,143 and 7,144.—Powell "Titan" lever gate throttle valve and operating parts. ***The parts are:*** B, spindle; C, carrier, terminating in a tapering wedge D; F, F, two links loosely coupled to carrier at upper end and engaging studs of the discs E, E, at lower end. ***In operation,*** the wedge D, gets in its work upon the disc studs only as the rotation of the spindle reaches a dead center in the downward stroke. The reverse movement of the carrier, it will be noted, first lifts the wedge from between the discs before the latter begin to move, then, as the discs fall loosely away from their seats they are carried up to the full opening without friction on the seats.

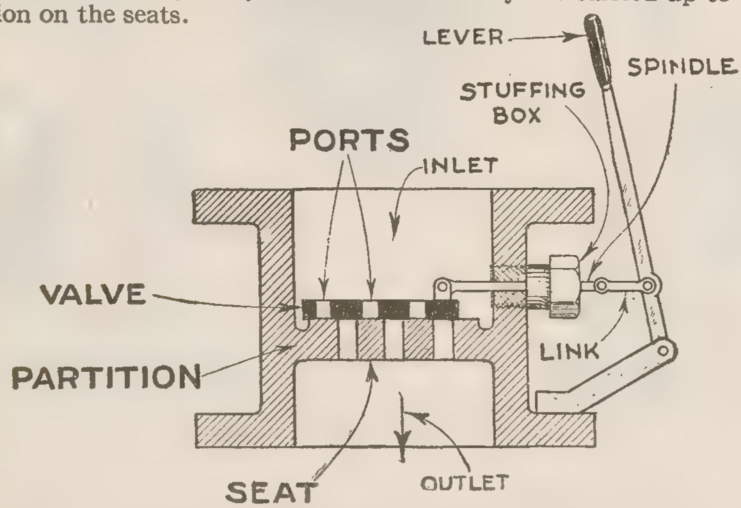


FIG. 7,145.—Gridiron form of gate (quick opening) throttle valve ***with single seat.*** This works on the same principle as a slide valve. Being unbalanced it requires some effort to move the lever, especially in the case of high pressure or large size valve so that the tendency in operating the valve is to give too little or too much opening, in the latter case putting a sudden load on the engine.

There are however, gate valves designed especially for throttling as shown in figs. 7,143 and 7,144.

A throttle gate valve with a single seat is shown in fig. 7,145. It is important in installing this form of valve to distinguish between the inlet and outlet as, since the valve simply rests on its seat, if pressure be applied to the outlet end it would be lifted off its seat and permit flow; moreover, in case of heavy pressure the spindle might be damaged.

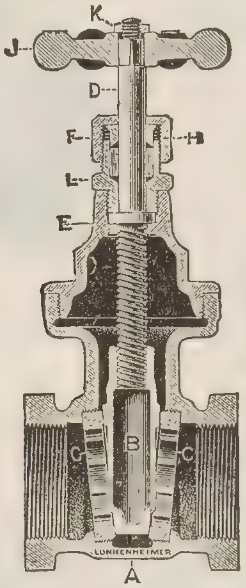
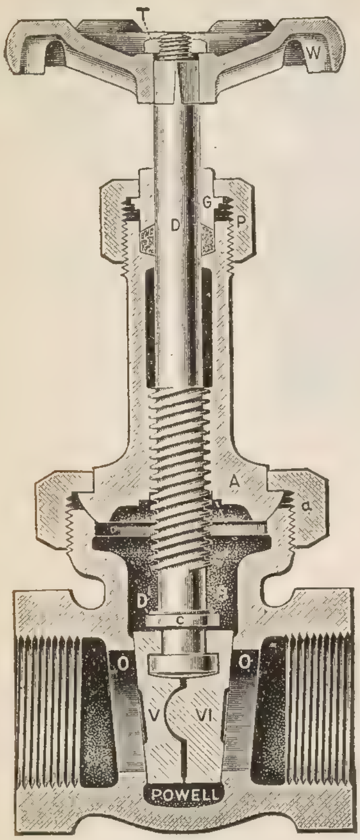
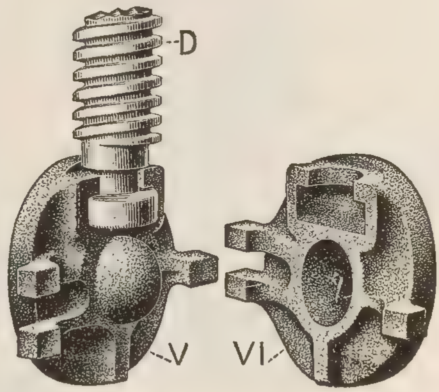


FIG. 7,146.—Lunkhenheimer "Wedge," ***single disc*** gate valve. ***The parts are:*** B, single disc; C, C, seats; D, spindle; E, bonnet; F, packing nut; H, gland; J, hand wheel; K, hand wheel nut; L, stuffing box. The travel of the disc is guided by splines cast integral with the sides of the body; the renewable seat rings C, are provided in 1 in. and larger sizes; the gland H, in stuffing boxes of ¾ in. and larger sizes, and the stuffing boxes of all sizes are repackable under pressure with valve fully opened.

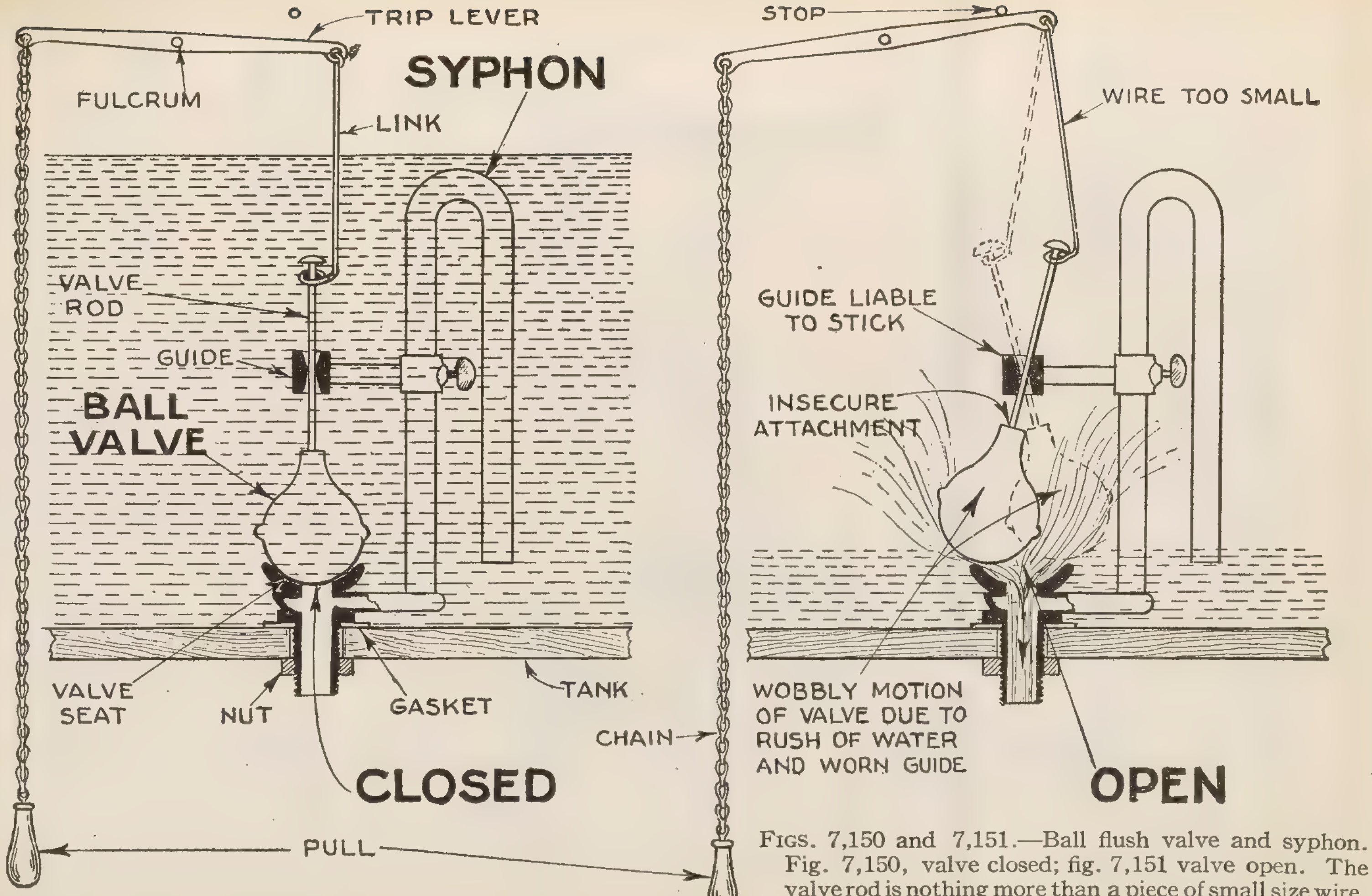
Figs. 7,146 and 7,147 show construction of the ordinary types of gate valve not intended to be used as throttles.

Flushing Valve.—This type of valve *is fitted to water closet tanks for the purpose of admitting water to the closet in flushing.* It is usually combined with a syphon device which in case the ball inlet valve does not close water tight when the tank is full, will syphon the water from tank, thus preventing an overflow





FIGS. 7,147 to 7,149.—Powell double disc gate valve. ***The parts are:*** A, bonnet; ***a***, bonnet nut; B, body; C, spindle collar; D, spindle; D′, bonnet chamber; G, gland; O, O, seats; P, packing nut; T, hand wheel nut; V, VI, discs; W, hand wheel. ***In construction and operation:*** the discs hang loosely on the double forcing collar C, at the base of stem D. The first turn of the hand wheel in opening the valve loosens the discs, so that no matter how high the pressure may be there is no wedging of the discs by the pressure. The final turn of the hand wheel in closing expands the discs against the seats. The discs are guided to their seats by interlocking lugs cast on the sides of the discs, which travel in a groove in the body shell, the discs come to a stop when reaching the bottom of the opening and are forced tightly against the tapering seat faces by the pressure through the stem, and being pivoted on the ball and socket back insures perfect seating. The seats O, O, are set at an angle. When the valve is closed the ball and socket back V, VI, operating in conjunction with the forcing collars C, expand the discs, thus closing the valve tight and preventing any leakage. When the valve is wide open, the discs are lifted entirely away from the opening without impeding in any way the flow of the steam. When the valve is opened but partially, it stays in the desired position without any possibility of alteration by the pressure. The stem D, is made with forcing collar between which the discs are hung. The thread of the stem is cut a true Acme or square thread. There are sufficient threads to always keep the stem firm in its position. The packing is wound around the stem and is forced into the recess by gland G, to which pressure is applied by wrenching down packing nut P. The stem can be packed with the valve wide open, as the upper face of the forcing collar C, is made to fit snugly in the lower face of bonnet A, forming a tight joint and not allowing any steam to pass.

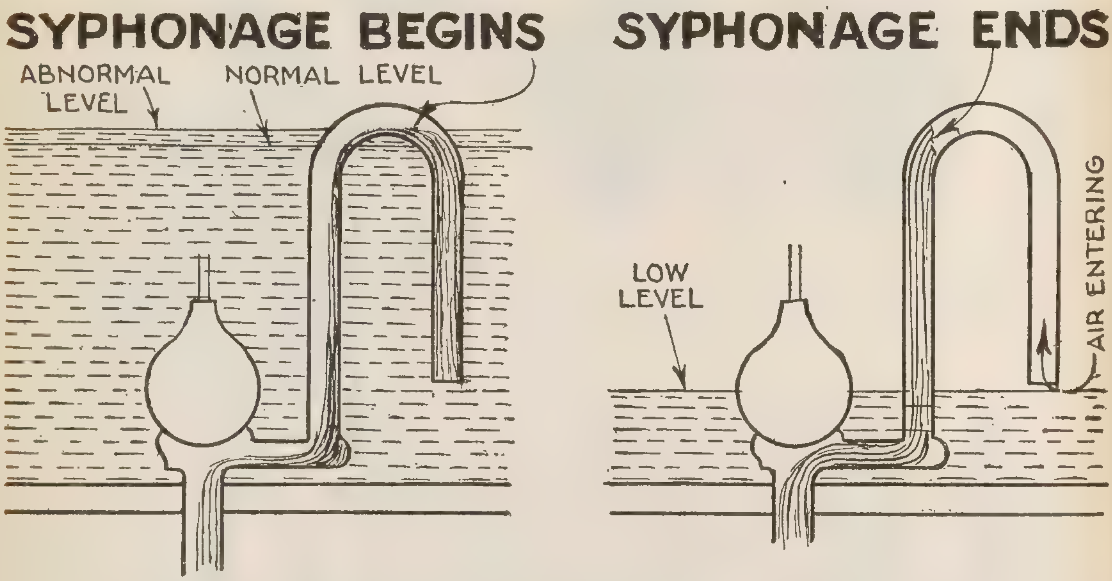


FIGS. 7,150 and 7,151.—Ball flush valve and syphon. Fig. 7,150, valve closed; fig. 7,151 valve open. The valve rod is nothing more than a piece of small size wire. The guide being at some distance above the ball, the latter is pushed about considerably at each flushing due to the tremendous rush of water; this tends to loosen up the screwed joint and bend the wire. The wire is also liable to be bent by the plumber in installing or repairing. A slight bend will put ball out of alignment and cause improper seating. Moreover, if the wire be bent it is liable to stick in the guide.

and give audible indication that the inlet valve is not working properly.

Flushing valves are made in a multiplicity of types.

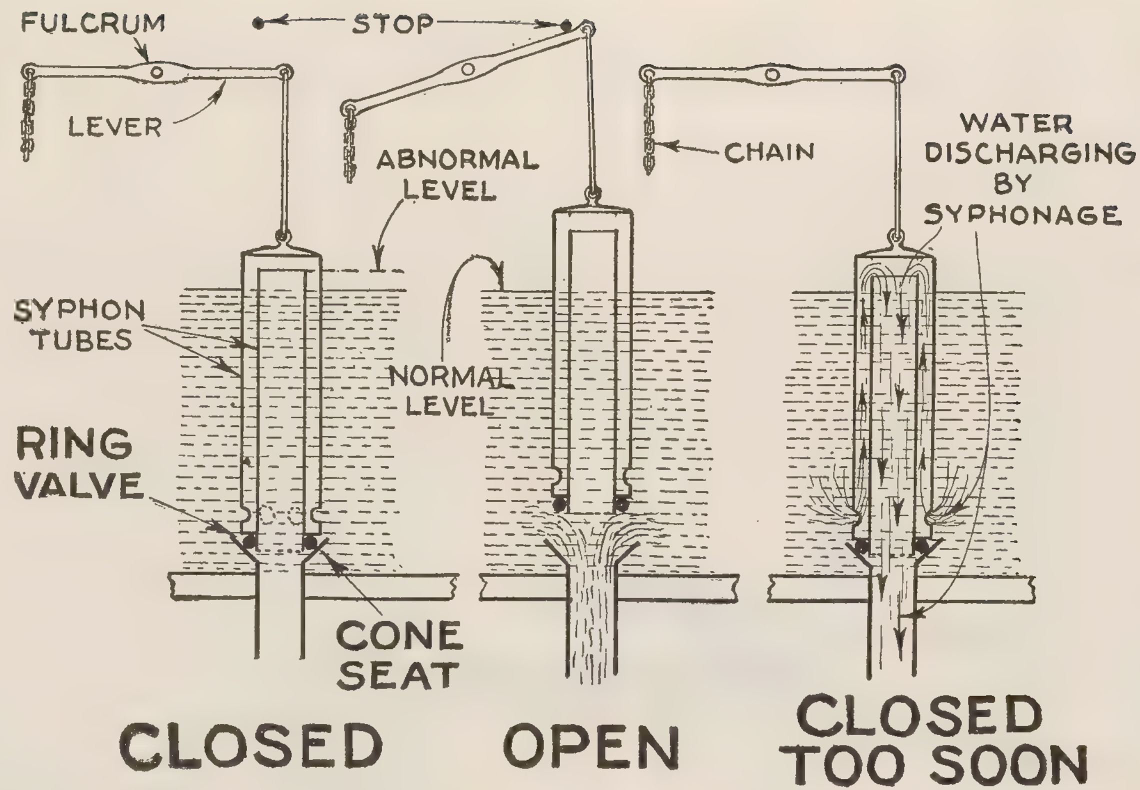
Figs. 7,150 and 7,151 show the essentials and operation of the rubber ball type and also its undesirable features. Although extensively used it is in the opinion of the author as poor a makeshift as could be devised. Fig. 7,151 speaks for itself.



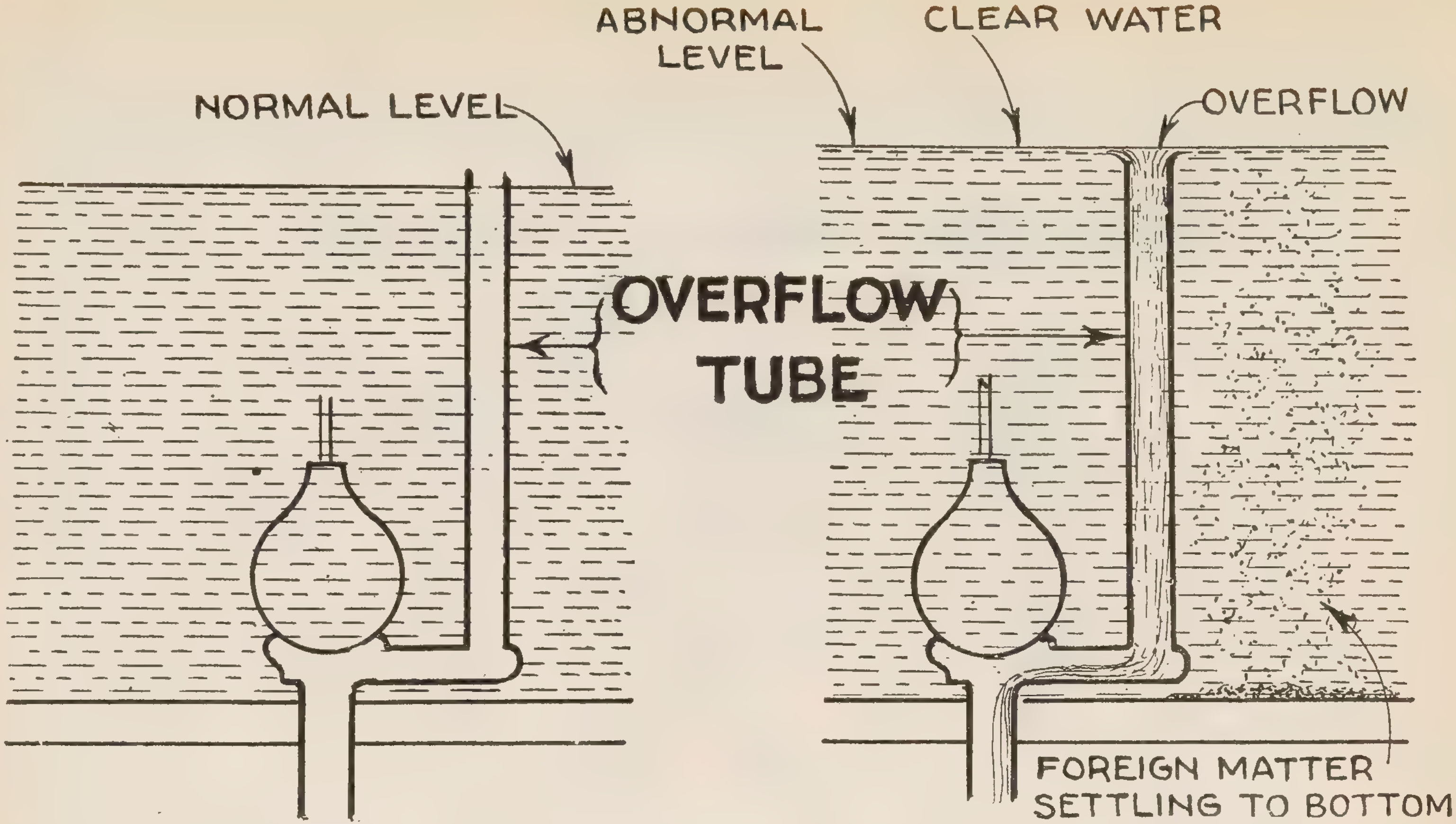
FIGS. 7,152 and 7,153.—Operation of closet tank syphon device, as usually fitted to flush valves.

The operation of the syphon attachment is shown in figs. 7,152 and 7,153 and the overflow tube sometimes used in place of the syphon in figs. 7,157 and 7,158.

Another objection to this class of flush valve is that its action depends upon the personal element, the flush being shut off as soon as the chain is released. Flush tanks are proportioned to hold the proper amount of water to thoroughly flush out the closet and there are few people who will hold down the pull until the tank is emptied. To overcome this defect a syphon valve is used. This is a combined flush valve and syphon as shown



FIGS. 7,154 to 7,156.—Operation of syphon type flush valve design to secure discharge of all the water in the tank for adequate flushing in case valve be closed before tank is emptied. This may be classed as a semi-automatic valve. The syphon device as can be seen from the illustration will operate in case the water rise above a predetermined level due to leaky inlet valve, thus preventing overflow, and give audible indication that the inlet valve is not working properly.



FIGS. 7,157 and 7,158.—Operation of closet tank overflow tube. ***Where the water is bad,*** containing sand, grit, or particles of rust, it is advisable to protect the ball valve by providing intake for overflow from the surface instead of near the bottom of tank. This gives a continuous overflow in case of leaky inlet valve instead of the intermittent emptying of tank with the syphon device.

in fig. 7,157, so constructed that if the valve be closed before the tank is emptied the water remaining in the tank will be discharged through the overflow tube as shown in fig. 7,158.

Blow Off Valve.—The object of a blow off valve is to provide means for discharging mud, scale, and other impurities which enter the boiler in the feed water.

The chief difficulty encountered with the blow off valve is leakage which is greatly aggravated by the presence of boiler scale.

When scale is removed by the use of kerosene and other agents, it comes off in small pieces, as well as large ones, and these accumulate in the blow off pipe.

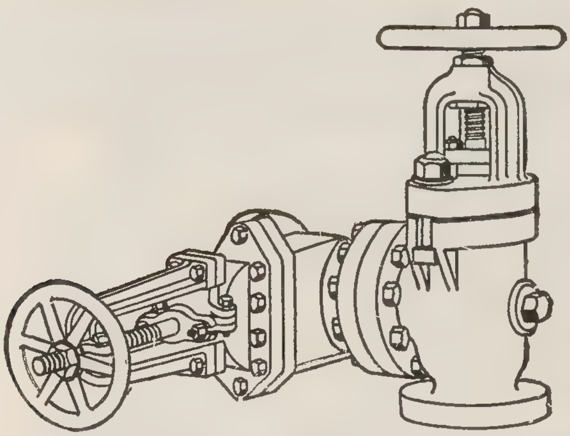


FIG. 7,159.—Lunkenheimer "Duro" blow off valve and "Victor" gate valve bolted together. Blow off valves have probably given more trouble than any other boiler fitting. Many kinds have been offered upon the market, which are claimed to possess the chief requisite in valves of this kind, that is, durability, but in practice they all appear to lack this essential feature. The combination of a blow off and gate valve as above is extensively used. This combination has many advantages that cannot be obtained by the use of a blow off valve alone. The gate valve is used as an emergency valve, should accident happen to the blow off valve, in which event the former can be closed until repairs are made. It not only serves as an emergency valve, but also insures a perfectly tight blow off arrangement. The gate valve should be opened and closed but once a day, being closed after the last blow off and opened early in the morning. ***It is essential,*** however, that the gate valve be operated at least once in twenty-four hours in order to prevent it becoming inoperative.

When the valve is open, these (in the ordinary valve) are hurled against the seat with great force and grind the surface of the seat and valve away, rendering it difficult to maintain a tight valve for more than a few months without repairs. In order to guard against this grinding action, a blow off valve should be so constructed that the valve and seat, when open, are out of the path of the escaping water and impurities. An example of such construction is the *plug cock*, and this has been found more serviceable

than either a gate valve or some special forms of blow off valve. Some of the latter provide a self-cleaning feature, while closing, while in others, the valve and valve seat are protected while open. The most desirable valve contains a combination of these features.

If angle valves be used they should be provided with a removable plug to permit running a rod into the pipe when cleaning the boiler in order to clean the pipe.

Ques. How should a blow off valve be connected to a boiler?

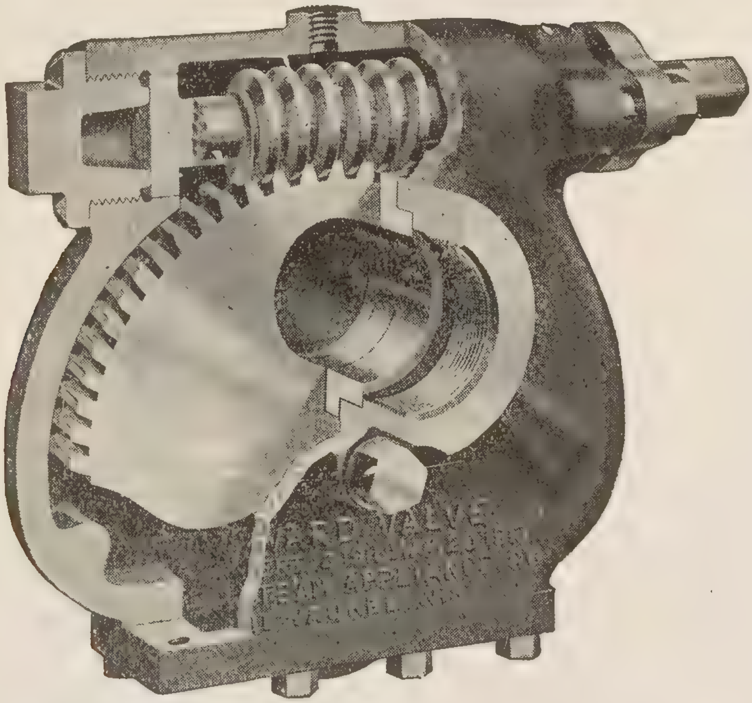


FIG. 7,160.—Ward worm gear blow-off valve. ***In construction,*** the body of the valve is made of semi-steel and the working parts of admiralty bronze.

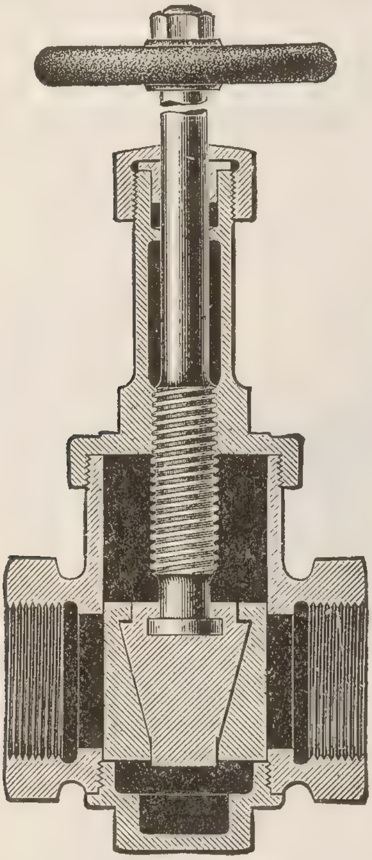
Ans. A gate valve should be placed between the blow off valve and boiler.

Ques. Why?

Ans. To insure a tight outlet and to provide additional means

of shutting off the connection in case anything happen to the blow off valve.

Ques. How should a blow off connection be made on a horizontal return tubular boiler?



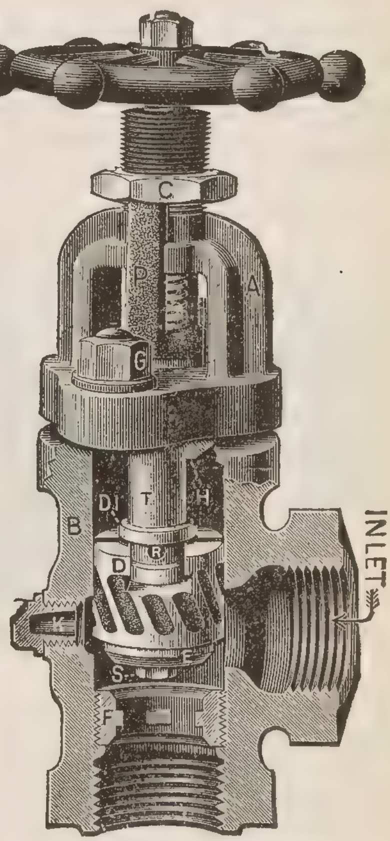


FIG. 7,161.—Star wedge adjustment blow-off valve. ***In operation, when closing***, the wedge expands the split piston, which is accurately fitted to the cylindrical chamber; in ***opening***, the first movement of valve spindle releases pressure of wedge on the piston, and then wedge raises piston to full opening of the valve.

FIG. 7,162.—Powell-regrinding blow-off valve. ***In construction***, the yoke top A, is secured to the body by studs G. The packing is adjusted by pusher gland P, which is operated by the outside screw nut C, above the bridge of yoke A. The faces D1 and H, fitting tight, permit repacking under pressure. The brass plunger D, is milled to receive the collar on stem T. Spiral grooves are cast on the outer face, which, receiving the pressure from the steam as the valve is opened, cause it to revolve as it nears the seat when closing. This gives the disc a grinding motion and keeps both disc and seat clear of scale and sediment. The seat ring F, is extended downward to protect it from the cutting effect of the rushing water and steam as the valve is opened. To this plunger is attached disc E, secured by nut S. By removing plug K, the inlet pipe from boiler can be cleared of sediment or scale. ***To regrind***, insert a plug or nail through the hole R; this locks the disc, then rotates back and forth with fine brickdust or sand on the bearing.

Ans. The boiler shell is tapped at the rear end for the blow off pipe. The latter should preferably be run straight down to below the floor level of the combustion chamber and then out, the pipes in the combustion chamber being protected from the heat by some insulating material as tile, brick, etc.

Check Valve.—This is a form of stop or non-return valve used to control the admission of feed water into a boiler or other apparatus.

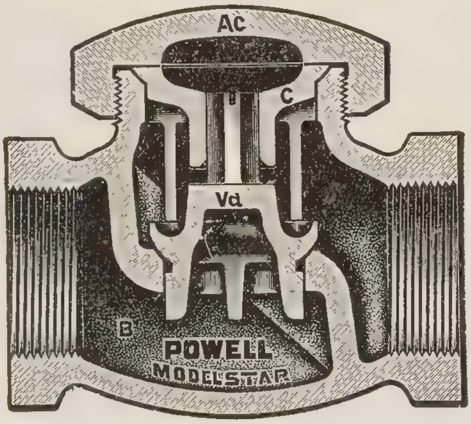


FIG. 7,163.—Powell disc check valve. The check disc V*d*, has integrally cast wing guides, which snugly engage within the guide C, auxiliary guides being provided below the disc. ***To regrind,*** remove bonnet A*c*, lift out guide C, place a little fine sand or ground glass and water on the disc face, replace same in the body B, and apply a screwdriver to slot in disc stem. Rotate back and forth until a good bearing is obtained, then carefully wipe off the ground glass or sand and replace valve guide C, and screw on bonnet.

The pressure within the boiler keeps the valve upon its seat unless overcome by superior pressure caused by the pump or injector, thus permitting feed water to enter while preventing its escape from the boiler.

Check valves on marine and other boilers sometimes have adjustable lifts, controlled by a wheel and spindle, but those designed for use on locomotives are generally non-adjustable, as only one boiler has to be considered.

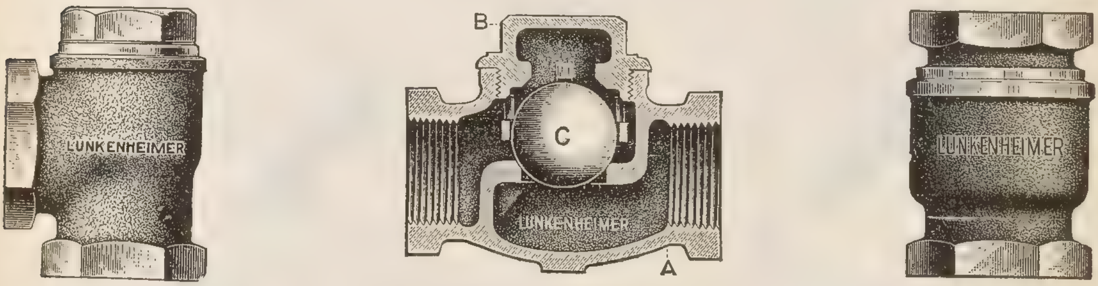
There are several kinds of check valve, as:

1. Disc check.

2. Ball check.
3. Swinging check.
4. Adjustable check.

Fig. 7,163 shows a disc check valve which is the form generally used. It has but three parts: the main casting, valve, and bonnet.

According to Hutton the valve should be sufficiently large in diameter to deliver the water with a lift not exceeding $\frac{1}{8}$ inch, higher lifts resulting in rapid destruction of the valve seat from the hammering action of the valve, especially when used with engine driven pumps. Of course with an injector when the feed is continuous, the valve remains off its seat while the injector is in operation, and accordingly a higher lift is not objectionable.



FIGS. 7,164 to 7,166.—Lukenheimer ball check valves. Fig. 7,164, angle pattern; fig. 7,165; horizontal pattern; fig. 7,166, vertical pattern. ***The ball type of check*** consists of three parts: A, seat casting; C, ball; B, bonnet. It meets the requirements for users of this type of check valve, but is not desi rable for sizes above 3 inches because of the high cost and weight of the ball.

The author believes that in determining the size of a check valve its *area of valve opening*, for a satisfactory lift, should be such that the rate of flow will not exceed 200 feet per minute. A method of figuring the area required is given in the following example:

Example.—A certain boiler requires 1,000 lbs. of feed water per hour. Determine feed check valve opening and diameter for $\frac{1}{8}$-inch lift, 45° beveled seat and a flow of 200 feet per minute.

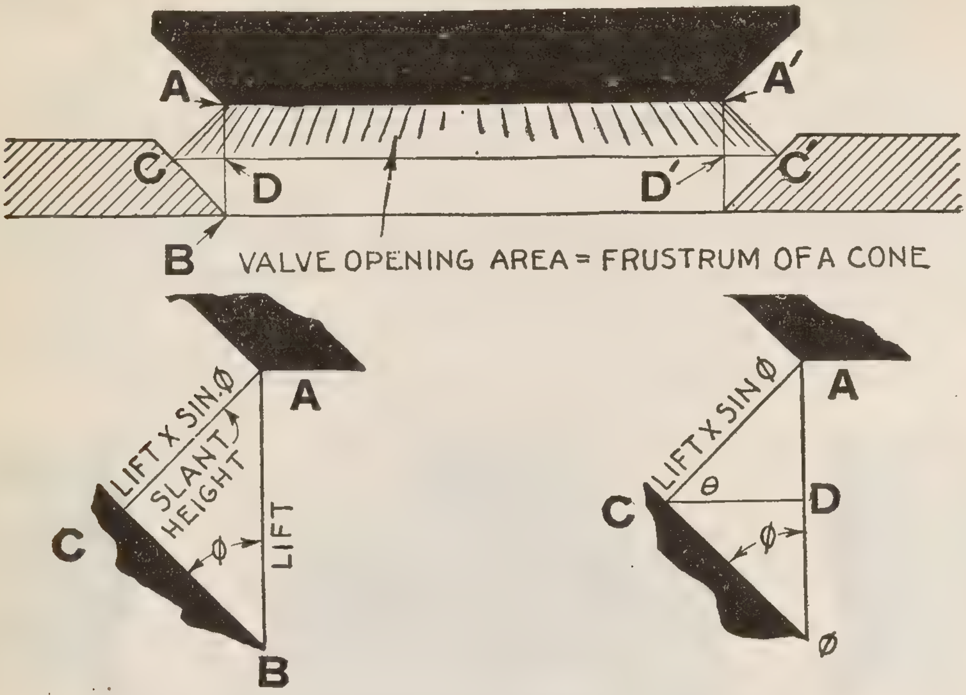
1 cubic foot of water at 212° (from table) weighs 59.76 pounds, hence volume of 1,000 pounds water $= 1{,}000 \div 59.76 = 16.74$ cu. ft. per hour, or

For a flow of 200 feet per minute.

$$\text{valve opening area} = \frac{16.74 \text{ cu. ft.} \times 144 \text{ sq. ins.}}{60 \text{ minutes} \times 200 \text{ ft.}} = .2 \text{ sq. in.}$$

Now for a beveled seat, the effective valve opening area as shown in

fig. 7,167, is equal to the slant surface of the frustrum of a cone whose upper base diameter AA′ is equal to the diameter of seat opening.*



FIGS. 7,167 to 7,168.—Beveled valve and seat with diagrams, illustrating method of calculating valve opening area as explained in the accompanying *note*.

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*NOTE.—The slant surface is, obviously, perpendicular to the seat, and since the height of the slant surface is less than the lift, the capacity of a beveled valve is less than that of a flat valve. In fig. 7,168, AC, is the slant height, ϕ is the angle ABC, between the direction of lift and the valve seat, hence in triangle ABC,

$$\sin\phi = AC \div AB = \text{slant height} \div \text{lift}$$

for which

$$\text{slant height} = \text{lift} \times \sin\phi \quad \text{.......(1)}$$

Now, the area of the valve opening or frustrum of a cone = slant height × average base circumference.......(2)

In fig. 7,167, the diameter of the lower base CC′ is larger than diameter AA′ of the top base by the distances CD+C′D′ or 2 CD.

Now in fig. 7,168,

$$CD \div CA = \cos\theta$$

from which

$$CD = CA\cos\theta = \text{lift} \times \sin\phi\cos\theta$$

but since by construction $\phi = \theta = 45°$, and lift = $\frac{1}{8}$ inch

$$2CD = 2 \times \tfrac{1}{8} \times \sqrt{\tfrac{1}{2}} \times \sqrt{\tfrac{1}{2}} = \tfrac{1}{4} \times \sqrt{\tfrac{1}{2}} = .125$$

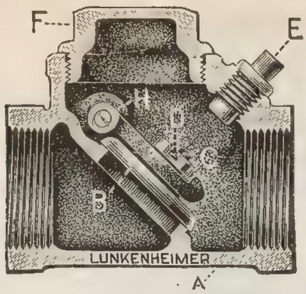
and calling the upper base diameter AA′, uniting, in fig. 0,006,

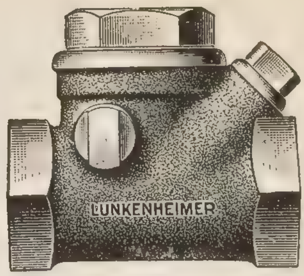
$$CC' = 1 + .125 = 1.125$$

hence average base diameter = $\frac{1}{2}(1+1.125) = 1.063$.......(3)

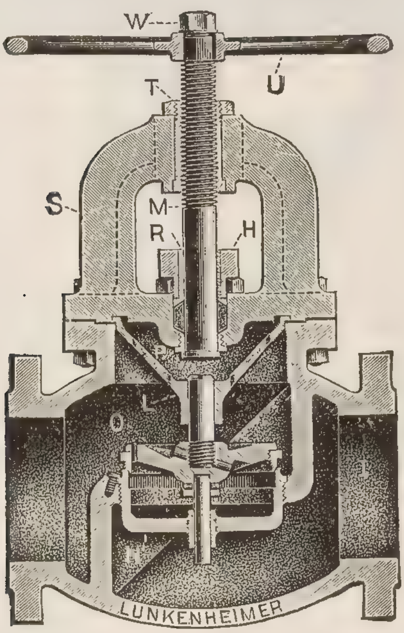
substituting given values in (1)

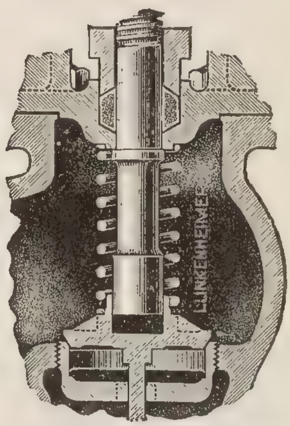
$$\text{slant height} \doteq \tfrac{1}{8} \times \sqrt{2} = .177 \text{ inches}$$





FIGS. 7,170 and 7,171.—Lunkenheimer swinging check valve. The design gives a valve opening area equal to that of the connecting pipes. The valve disc B, is attached by the nut D, to the carrier C, which is pivoted at H. The two side plugs serve as bearings for the pivot pin H. Should the movement of the pin cause the plugs to wear, they can be easily renewed at small expense. To prevent the disc lock nut jarring loose, a hole is drilled through both the lock nut and threaded end of disc, through which a wire is inserted. To regrind, unscrew bonnet F, and place some powdered glass or sand, and soap or oil on the seat; also unscrew plug E, opposite disc, which permits inserting a screw driver in the slot of the disc.





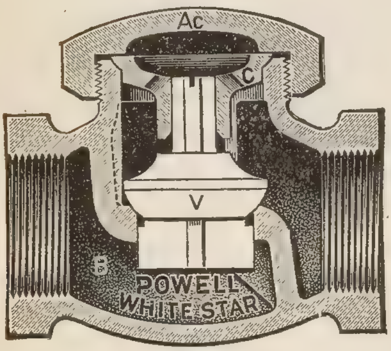
FIGS. 7,172 and 7,173.—Lukenheimer adjustable lift check valve. Fig. 7,172, valve without spring bearing on disc; fig. 7,173, detail showing valve with spring bearing on disc.

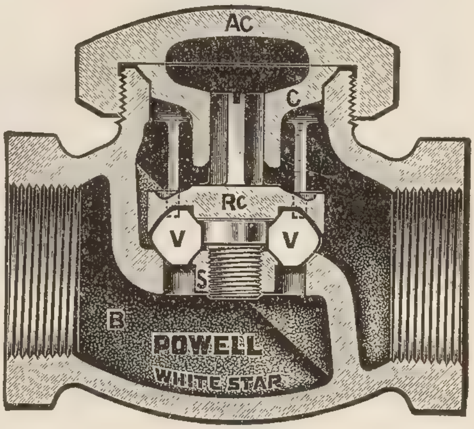
NOTE.—According to Hutton the cross sectional area of a feed valve in square inches = the evaporative capacity of the boiler in pounds $\times$.00082. For instance, for a boiler evaporating 6,000 pounds of water per hour, area $=6{,}000\times.00082=4.92$ square inches and

$$\text{diameter corresponding} = \sqrt{\frac{4.92}{.7854}} = 2\tfrac{1}{2} \text{ inches}$$

Figs. 7,165 and 7,170 show ball and swinging check valves.

In many places where check valves are used it is desirable to control the lift of the disc to prevent chattering. Fast running pumps bring severe duty on check valves causing them to open too wide and hammer; for such conditions it is desirable to have means for adjusting the lift as shown in figs. 7,172 and 7,173.





FIGS. 7,174 and 7,175.—Powell White Star check valves. Fig. 7,174, to ½ in. sizes, regrindable, but not reversible; fig. 7,175, ¾ and larger, regrindable, reversible and renewable. ***In construction,*** the body B, and the trimmings Ac,C,Rc,S are cast in the steam bronze composition as adopted by the U. S. Government for its Naval Service. In the sizes ⅛, ¼, ⅜ and ½ in. the disc V, is made in one piece, which operates in the guide collar C, and in these sizes is not reversible, but is regrindable and renewable. In the ¾ in. and larger sizes one of the faces of the disc is protected in the disc holder Rc, while the other is in service, as shown in the illustration. The wing guides work freely in the guide collar C, which is held rigid in the body by cap Ac. The parts are adjusted so as to bring the disc to an exact center, and therefore will seat true. To reverse the disc it is only necessary to unscrew nut S, which holds the disc in the holder Rc. ***To regrind check disc,*** remove cap Ac, apply grinding sand and water to face of disc, insert screw driver in slot in end of stem and rotate back and forth, until a good bearing is obtained. When lower face of disc is worn out, unscrew nut S, reverse the disc, tighten up nut S again, and grind to seat as described above.

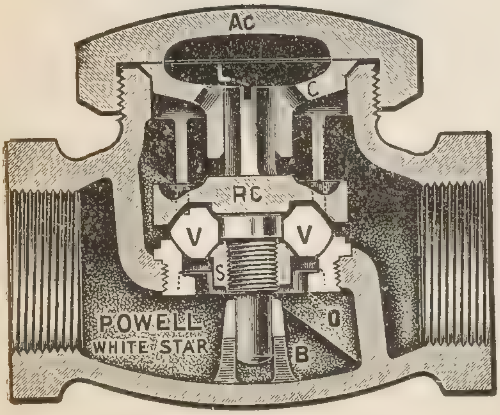


FIG. 7,176.—Powell White Star check valve with renewable bronze seat, regrindable, reversible, removable valve. In the ½ in. size the disc and stem is in one piece, in the ¾ in. and larger sizes the discs are reversible. The seats can be renewed when worn out by unscrewing same by means of the wrench lugs O. Simply insert a flat bar of steel of proper width to fill the diameter of the opening of seat and unscrew.

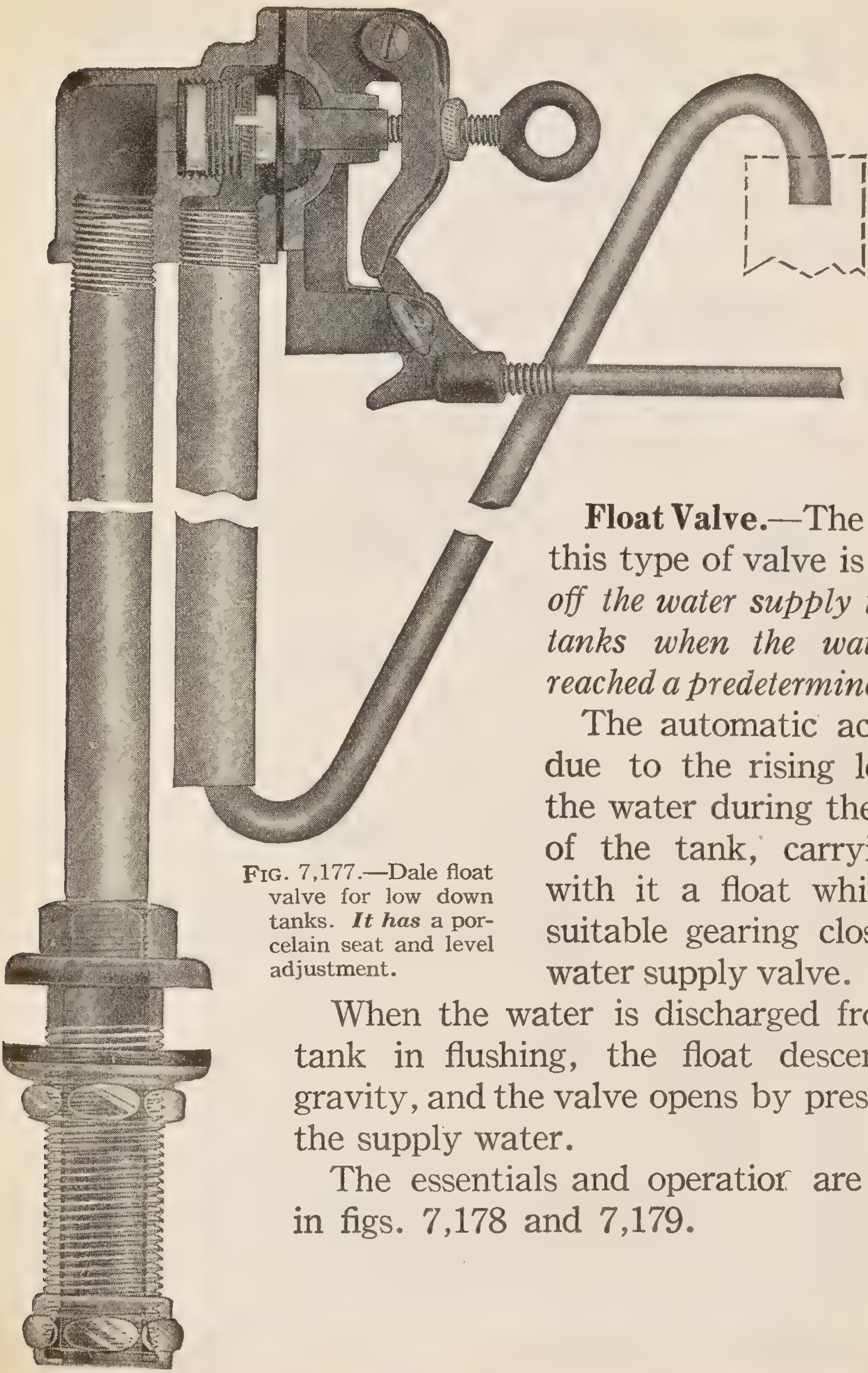


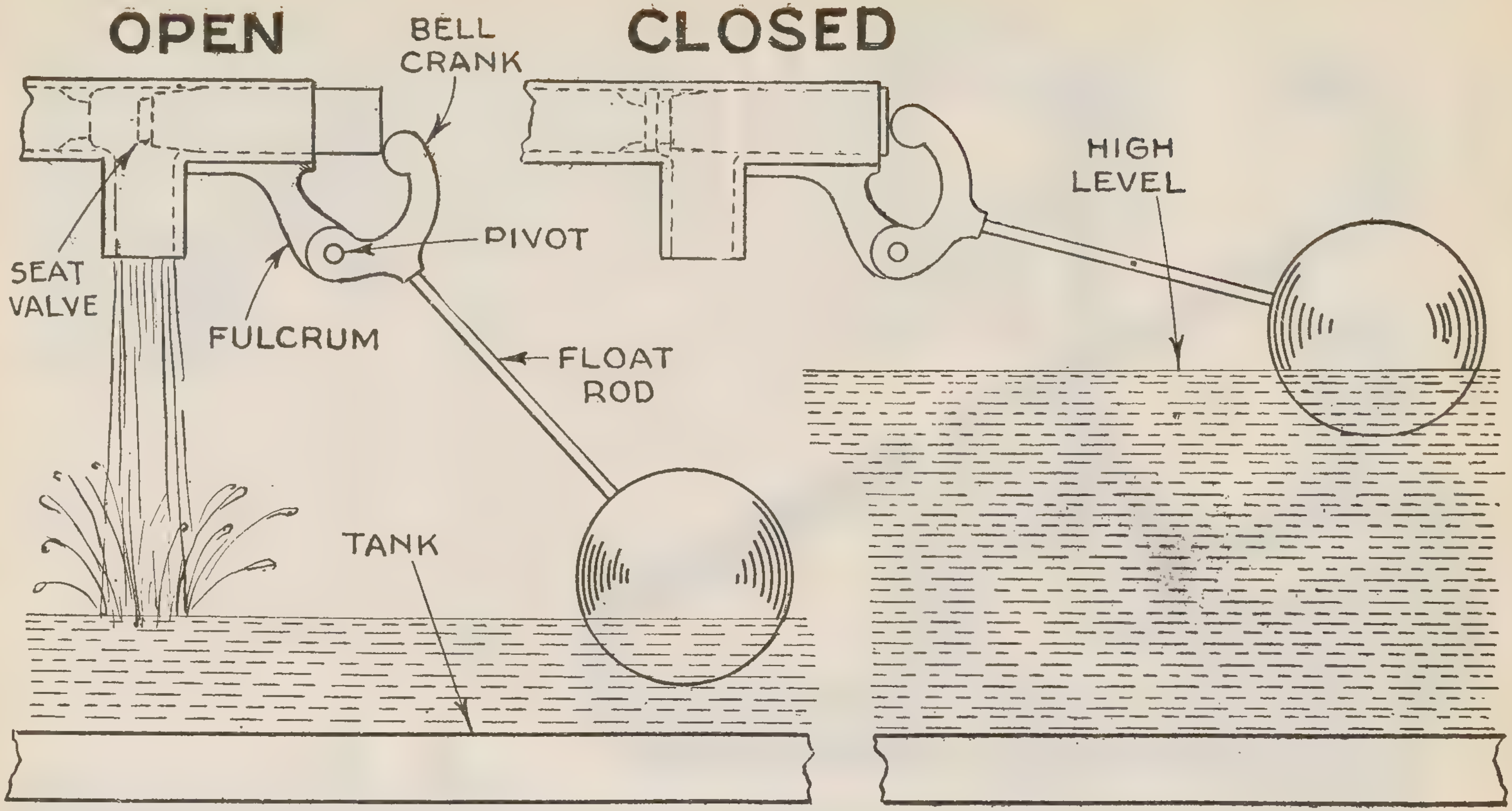
FIG. 7,177.—Dale float valve for low down tanks. *It has* a porcelain seat and level adjustment.

Float Valve.—The duty of this type of valve is *to shut off the water supply to closet tanks when the water has reached a predetermined level.*

The automatic action is due to the rising level of the water during the filling of the tank, carrying up with it a float which, by suitable gearing closes the water supply valve.

When the water is discharged from the tank in flushing, the float descends by gravity, and the valve opens by pressure of the supply water.

The essentials and operation are shown in figs. 7,178 and 7,179.



FIGS. 7,178 and 7,179.—Elementary float valve illustrating principle of operation. Fig. 7,178, ***valve open***, tank filling; fig. 7,179, ***valve closed***, tank full. The pressure of the supply water pushes valve from its seat and the tank begins to fill. The buoyancy of the float causes it to rise with the rising water level and being connected with the valve with suitable gear gradually closes the valve, shutting off the water when tank has filled to a predetermined level.

In practice there is a great variety of float valves all acting on the basic principle shown in figs. 7,178 and 7,179, but having various modifications of the transmission gearing. Usually some means of adjusting the water level at which the valve closes is provided. The principle of such adjustment is shown in fig. 7,180 and use should be made of this means of adjust-

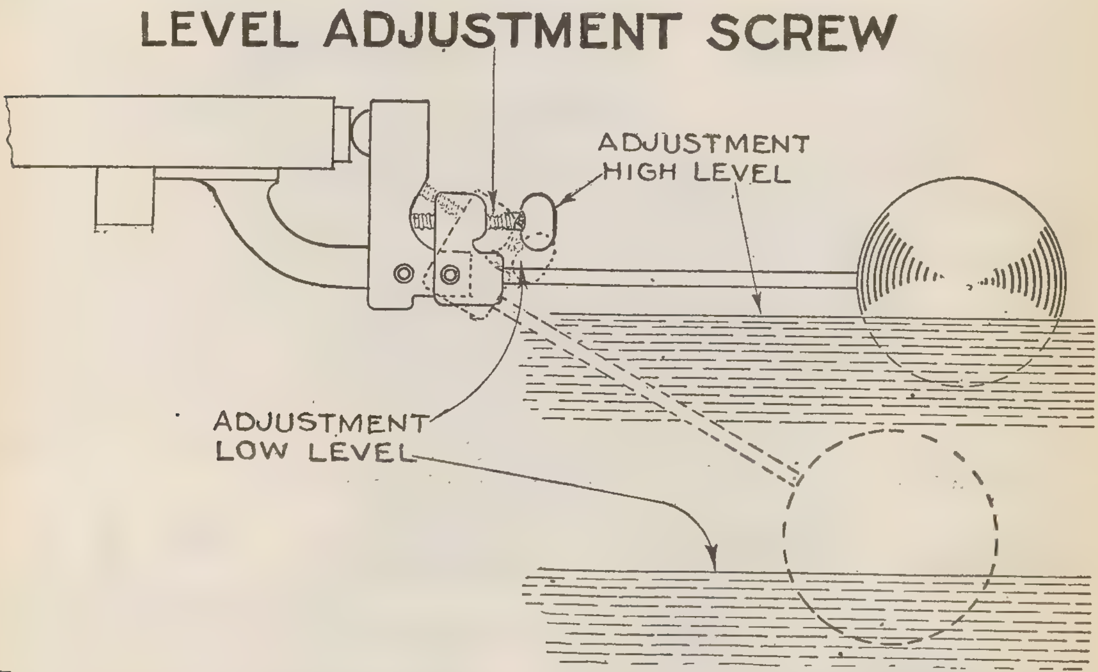


FIG. 7,180.—Principle of float valve level adjustment. *The level may be changed by altering the transmission angle of the bell crank.* ***In practice*** this is done, not by changing the angular position of the bell crank arms, but by providing an adjustable point of contact between one of the arms and the valve, as by screw adjustment.

ment when necessary rather than resorting to the objectionable practice of bending the float rod.*

Figs. 7,181 and 7,182 show how rod is bent to lower level from A to B, and possible result due to such practice. A form of valve employing a diaphragm is shown in open and closed position in figs. 7,183 and 7,184. It acts by hydraulic pressure depending upon the differential area principle to keep it closed.

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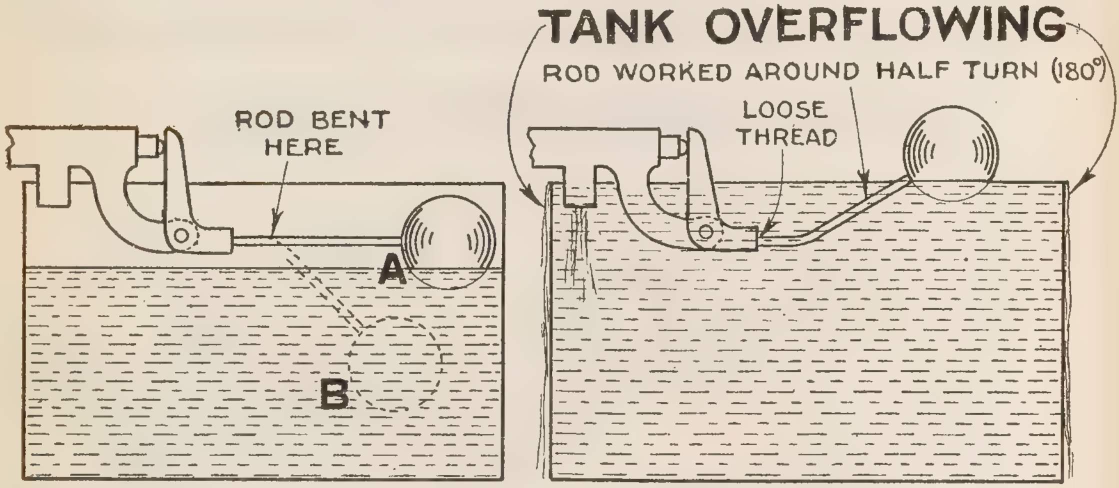
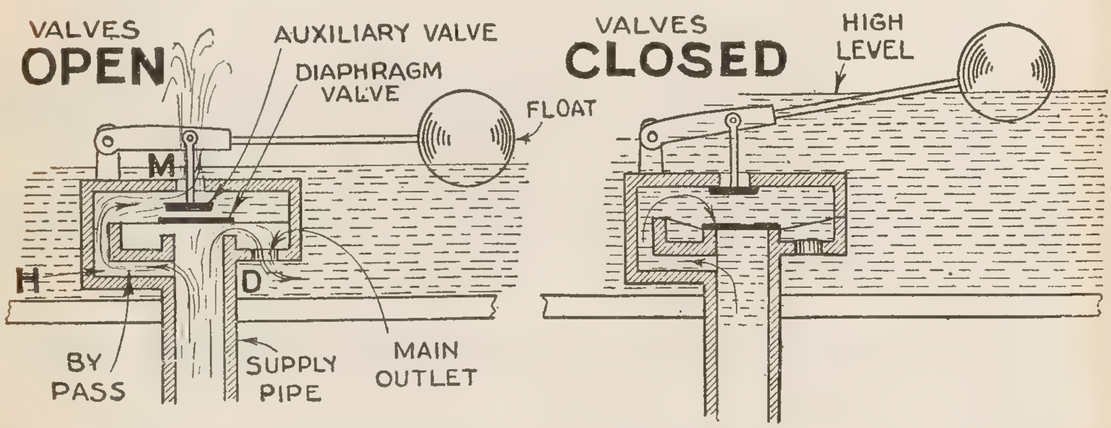
*NOTE.—A ***competent mechanic*** will do things in a mechanical way and a greenhorn, mechanical butcher, or slouch, otherwise.

In construction a diaphragm valve divides the valve chamber into two compartments. In the lower compartment is the valve seat of the diaphragm valve, outlet ports, and a by pass passage leading to the upper compartment which has no opening except that an auxiliary valve operated by the float as shown. This arrangement forms an efficient device and can be made to control the flow from a large tank with a small float.



FIGS. 7,181 and 7,182.—Makeshift method of bending the float rod to adjust water level in tank and how tank can overflow by this method of adjustment.



FIGS. 7,183 and 7,184.—Hydraulically operated diaphragm float valve. Fig. 7,183, open position; fig. 7,184, closed position. ***In operation,*** when the valves are open (fig. 7,183), water flows in supply pipe, passes into tank through main outlet D, and also through by pass H, and auxiliary valve M. The float rising with the rising water level gradually closes auxiliary valve M. When M, closes the top of the diaphragm is subjected to the full pressure in the supply pipe, and the lower side of the diaphragm to a slightly lower pressure due to drop by water flowing out through main outlet D. The excess pressure acting on the top side of the diaphragm is sufficient to push the diaphragm down and shut off the flow to tank. At the instant the diaphragm valve closes considerable additional force is made available to hold it down. This is explained in figs. 7,186 to 7,189.

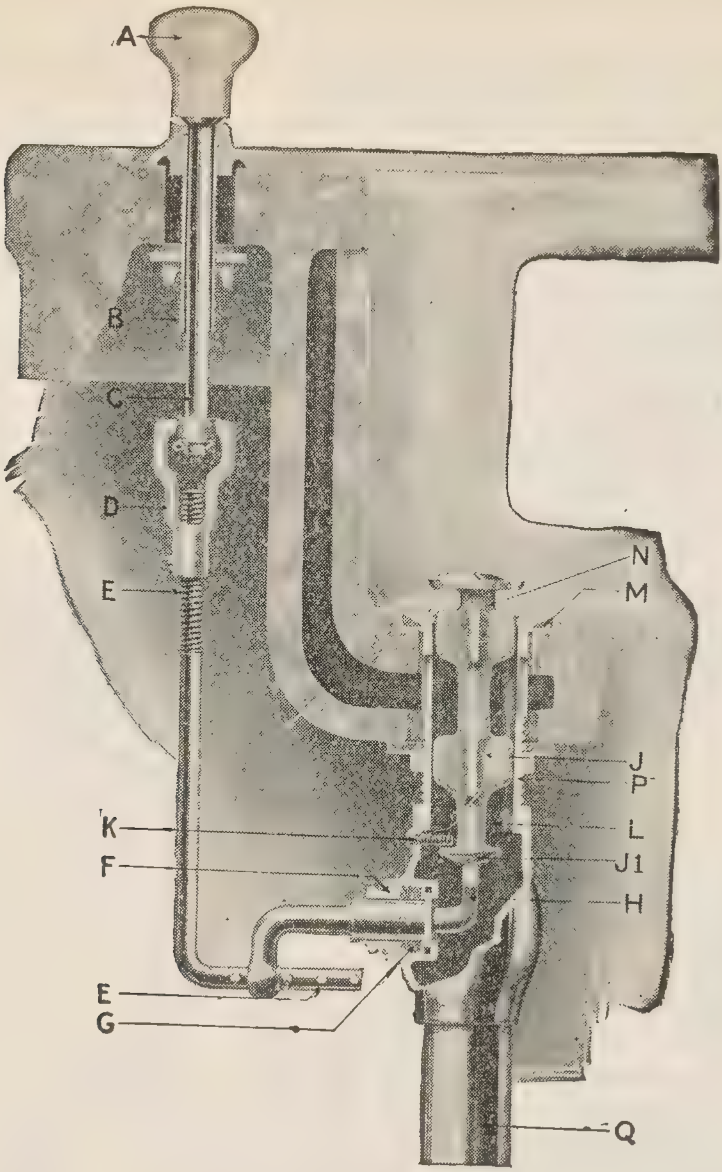
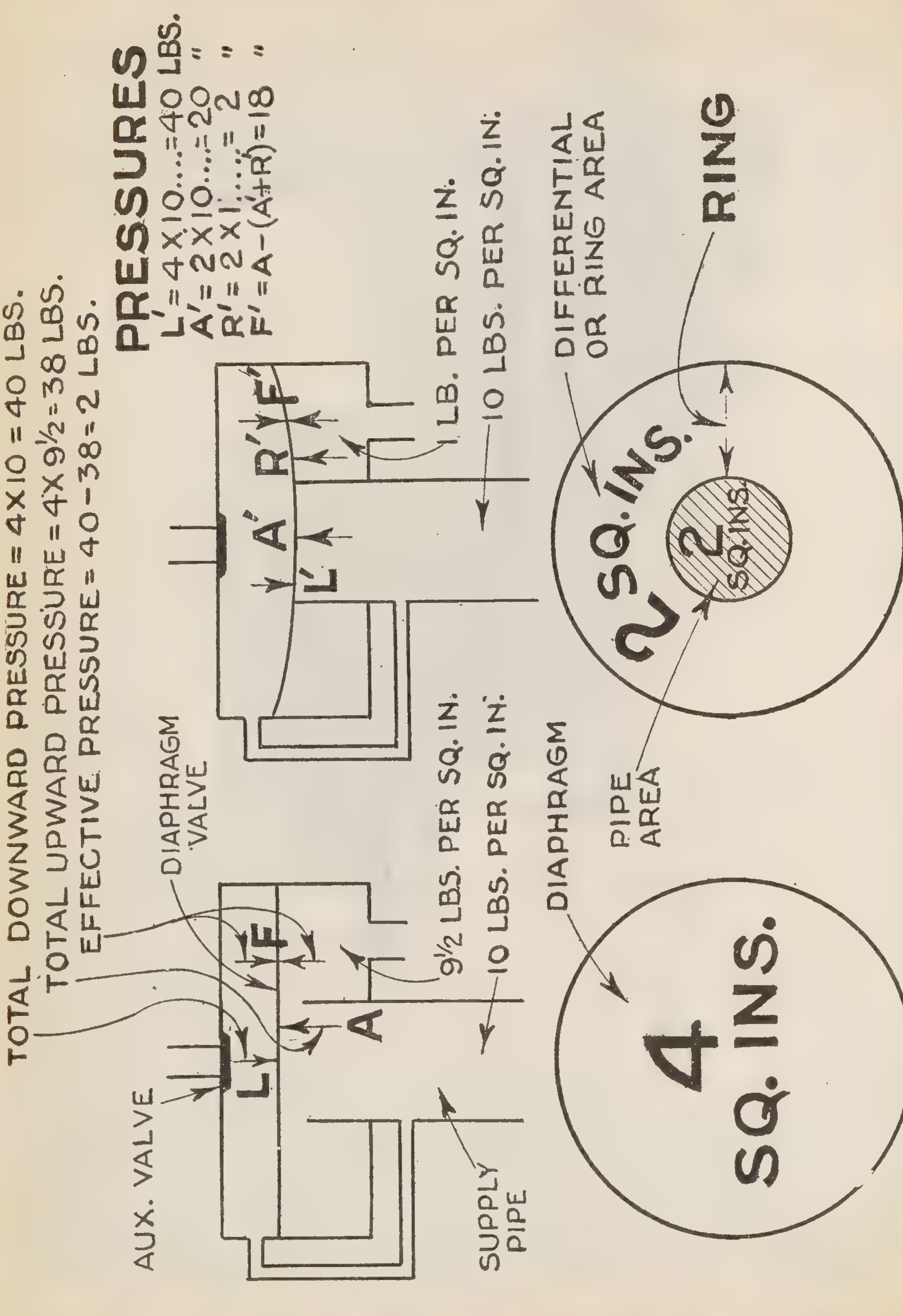


FIG. 7,185.—Speakman "Acto" pop up waste A, push down to open, pull up to close; B, guide tube which serves as a stop when rod C, is raised, thus preventing any strain on other working parts; C, operating rod revolves freely in turnbuckle, so no strain can be placed on other working parts; D, turnbuckle; E, ample adjustment to suit various sizes and types of lavatories; F, large packing chamber and packing nut, giving friction to hold plug open when lifted. G, packing; H, cam which lifts plug. ***In operation*** when the plug is fully lifted, cam H, is past center, and plug cannot be pushed down without lifting the knob; J, metal plug; J1, bottom of plug J, rests freely on cam H; K, screw to prevent removal of plug. Especially desirable in public rooms. However, plug can be easily removed for cleaning by loosening the screw. No necessity for removing any other parts; L, water way through plug body; M, beveled rubber washer for countersunk outlet. This washer can be discarded when used on lavatories having tapered outlet; N, lift of metal plug. No adjustment of plug necessary, thus insuring always seating and rapid discharge when opened; P, plug body with ample length thread and lock-nut to fit varying thickness of lavatories; Q, tail piece.



Figs. 7,186 to 7,189.—Skeleton diagrams of hydraulically operated diaphragm valve illustrating pressure conditions at closure of

FIGS. 7,186 to 7,189—*Text continued.* auxiliary valve (fig. 7,186), and at closure of diaphragm valve (fig. 7,187). Assume area of diaphragm (fig. 7,188) is 4 sq. ins. area of supply pipe 2 sq. ins., leaving a differential or excess area of diaphragm over supply pipe of 2 sq. ins. as in fig. 7,189. Assume also 10 lbs. per sq. in. pressure in supply pipe and upper chambers, and 9½ lbs. per sq. in. pressure in lower chamber before diaphragm closes. Then (fig. 7,189) total downward pressure $L = 4\times10 = 40$ lbs.; total upward pressure $A = 4\times9\frac{1}{2} = 38$ lbs.; effective pressure $= L - A = F = 40 - 38 = 2$ lbs. That is, when the auxiliary closes the effective pressure F, tending to close the diaphragm valve is 2 lbs. Now at the instant the diaphragm valve closes (fig. 7,187) the pressure in the lower compartments will drop to that due to the head of water in the tank, say 1 lb. per sq. in. Then, total downward pressure $L' = 4\times10 = 40$ lbs.; total upward pressure A', in supply pipe $= 2\times10 = 20$ lbs.; L' total upward pressure in ring area of diaphragm outside of supply pipe $R' = 1\times2 = 2$ lbs.; total upward pressure acting on diaphragm $= A' + R' = 20 + 2 = 22$ lbs.; effective pressure F', tending to hold diaphragm closed $= A' - (A' + R') = 40 - (20 + 2) = 18$ lbs. Thus it is seen that the diaphragm is pushed against its seat by a pressure of 2 lbs., and held there by a pressure of 18 lbs., the sudden increase being due to the drop of pressure in the lower chamber at the instant the diaphragm closes communication with the supply pipe.

Fig. 7,192 shows shank of float valve and method of securing tight joint when shank passes through bottom of tank.

Float valves for controlling the supply to house tanks work on the same principle as the overhead closet tank valve illustrated in figs. 7,190 and 7,191.

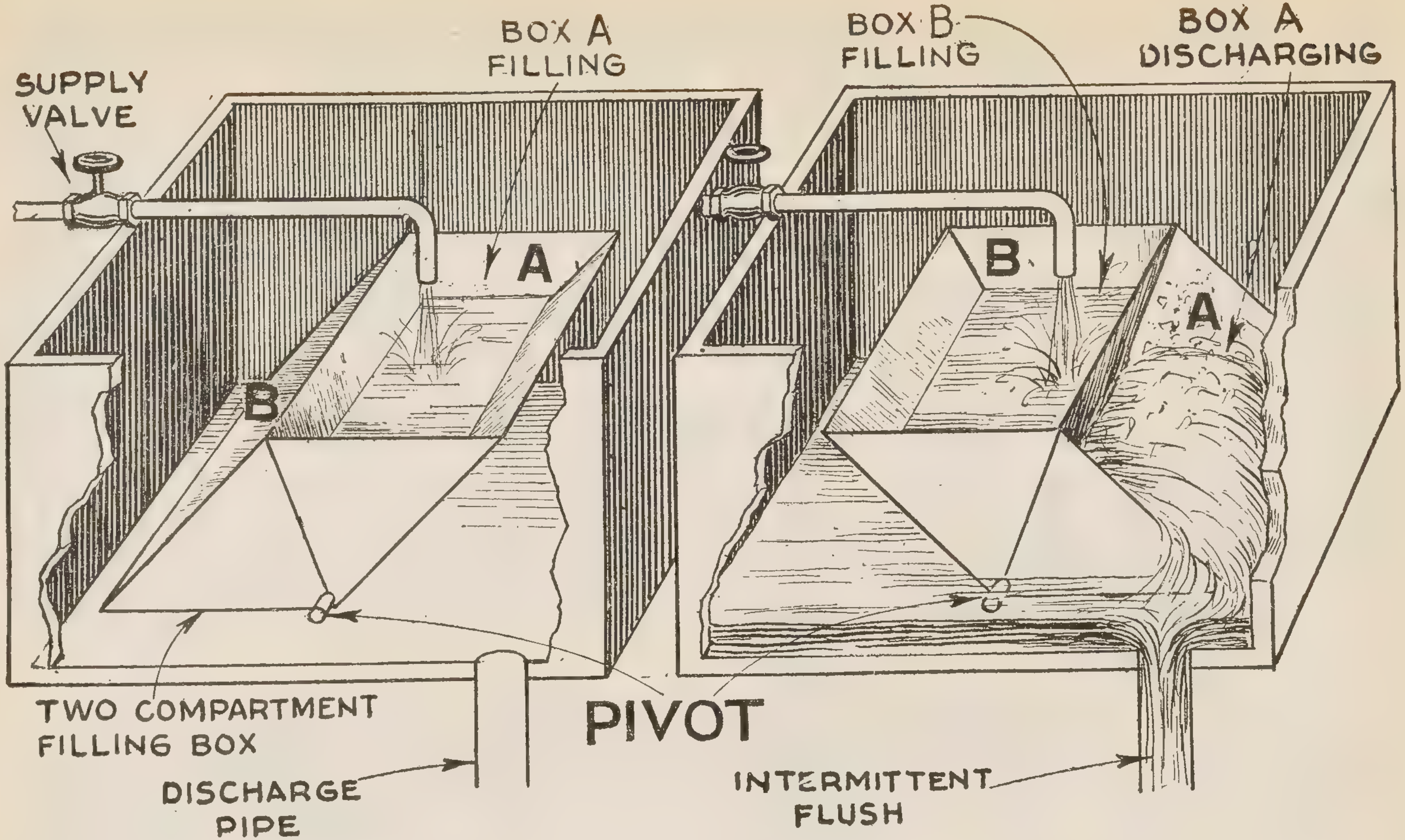
Radiator Air Valve.—*Ordinary water contains mechanically mixed with it about 1/20 or 5% of its volume of air when under atmospheric pressure.*

This air is too finely distributed to be seen. When the water is heated and converted into steam as in a steam heating system this air is *liberated* as explained in figs. 7,193 to 7,195.

For the efficient operation of radiators this air must be removed. For this purpose an air valve is provided.

Since air is heavier than the steam, the valve theoretically, should be placed as near the bottom of the radiator as possible, but to prevent possible flooding of the valve it is usually placed about halfway or two-thirds of the height of the radiator from the floor; also to help induce circulation of the steam it is placed on the side farthest from the steam inlet.

NOTE.—*Air* is a gas consisting of a mechanical mixture of 23% of oxygen (by weight) 76 per cent nitrogen and 1 per cent argon. Carbonic acid is present to the extent of about .03 or .04 per cent of the volume. Obscure constituents are .01 per cent krypton with small amounts of several other gases. One cu. ft. of air at 32° Fahr. and atmospheric pressure weights .080728 lb. At any fixed temperature the weight of a given volume of air is proportional to its absolute pressure.



FIGS. 7,190 and 7,191.—Intermittent flushing tank for automatically flushing urinal at regular intervals. ***In construction,*** the filling box is divided into two compartments and arranged to rock back and forth on pivots, presenting first one compartment and then the other under the outlet of the water supply pipe. ***In operation,*** (fig. 7,190), water slowly fills compartment A, causing its center of gravity to gradually shift to the right until it suddenly turns on its pivot and dumps the charge of water into the tank below from where it flows out and flushes fixtures as shown in fig. 7,191. When the filling box turns on its pivot so that A, discharges, compartment B, comes under the water supply, fills, and dumps in a manner similar to the dumping of A. Evidently by adjusting the rate of flow by the valve the intervals between flushings can be regulated.

There are two general classes of air valve.

1. Hand controlled.
2. Automatic.

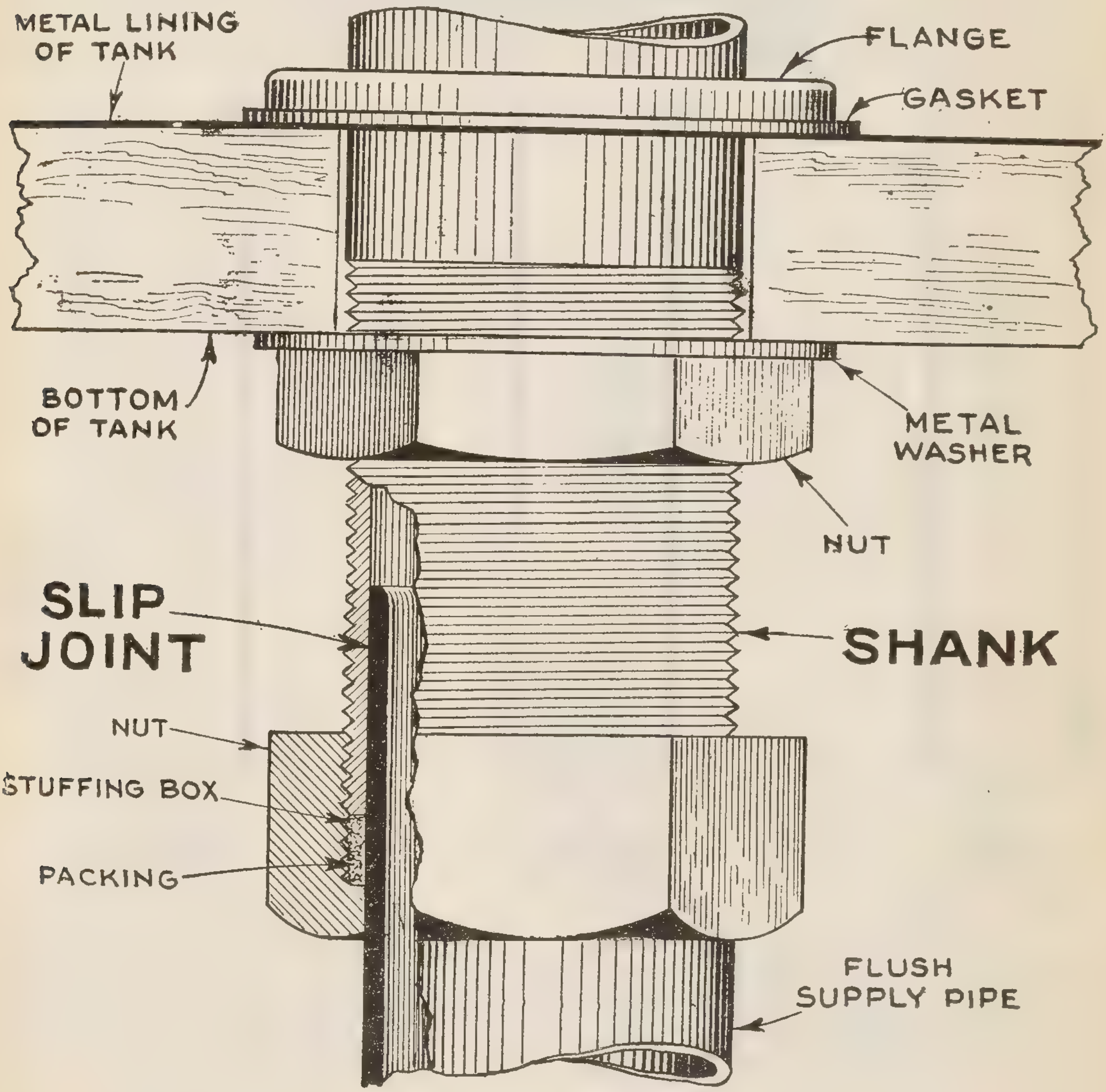
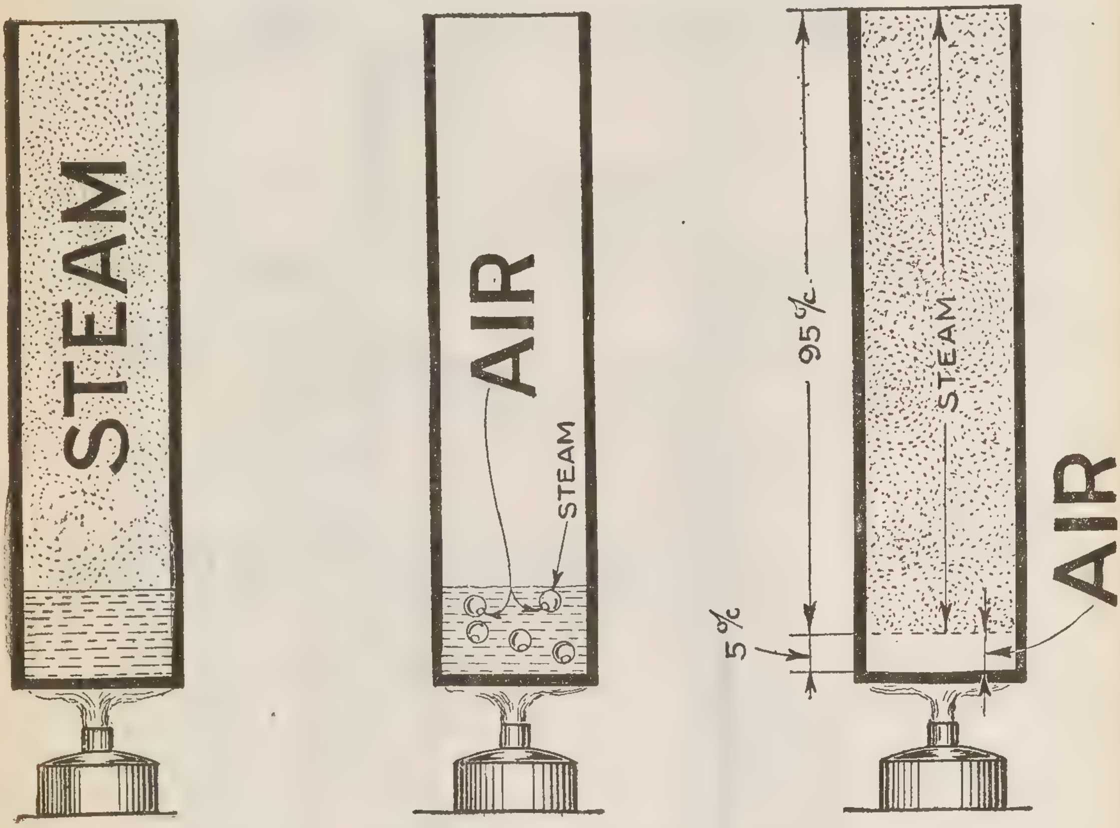


FIG. 7,192.—Shank of closet tank float valve showing method of securing a tight joint where shank passes through bottom of tank, and slip joint connection with water supply. The nut stuffing box should be packed with a washer made to fit the stuffing box. In the absence of same, a tight joint may be made with any approved packing suitable for the box.

The hand operated valve, a typical design of which is shown in fig. 7,196, is not well adapted for the purpose, because it

receives very irregular attention and air is constantly forming which should be removed as it forms.

What actually happens in a radiator is shown in figs. 7,197 to 7,200. After the air valve remains closed for some time the radiator gradually fills with air or becomes air bound as shown in fig. 7,197, the air being at the bottom and the steam at the top. On opening the valve the air is pushed



FIGS. 7,193 to 7,195.—***Liberation of air*** in the formation of steam. In fig. 7,193, assume the closed tube to contain a small quantity of water and steam and sufficient heat to be applied to convert the water into steam. ***During vaporization,*** each bubble will be made up of steam and liberated air as in fig. 7,194. When all the water has been converted into steam the tube will contain approximately 95% steam and ***5% air,*** as in fig. 7,195. Since the air is heavier than the steam it will remain at the bottom of the tube.

out by the incoming steam, the radiator gradually filling with steam as shown in figs. 7,198 to 7,200. When steam begins to come out of the air valve it should be closed.

The automatic valve (when it is in working order) is the proper valve to use.

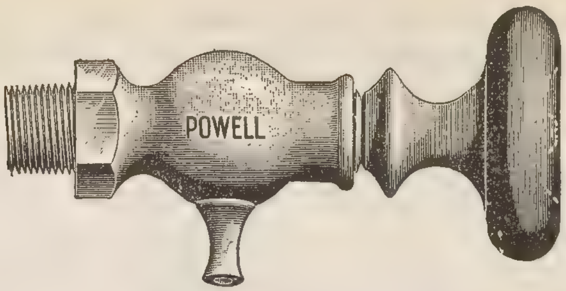
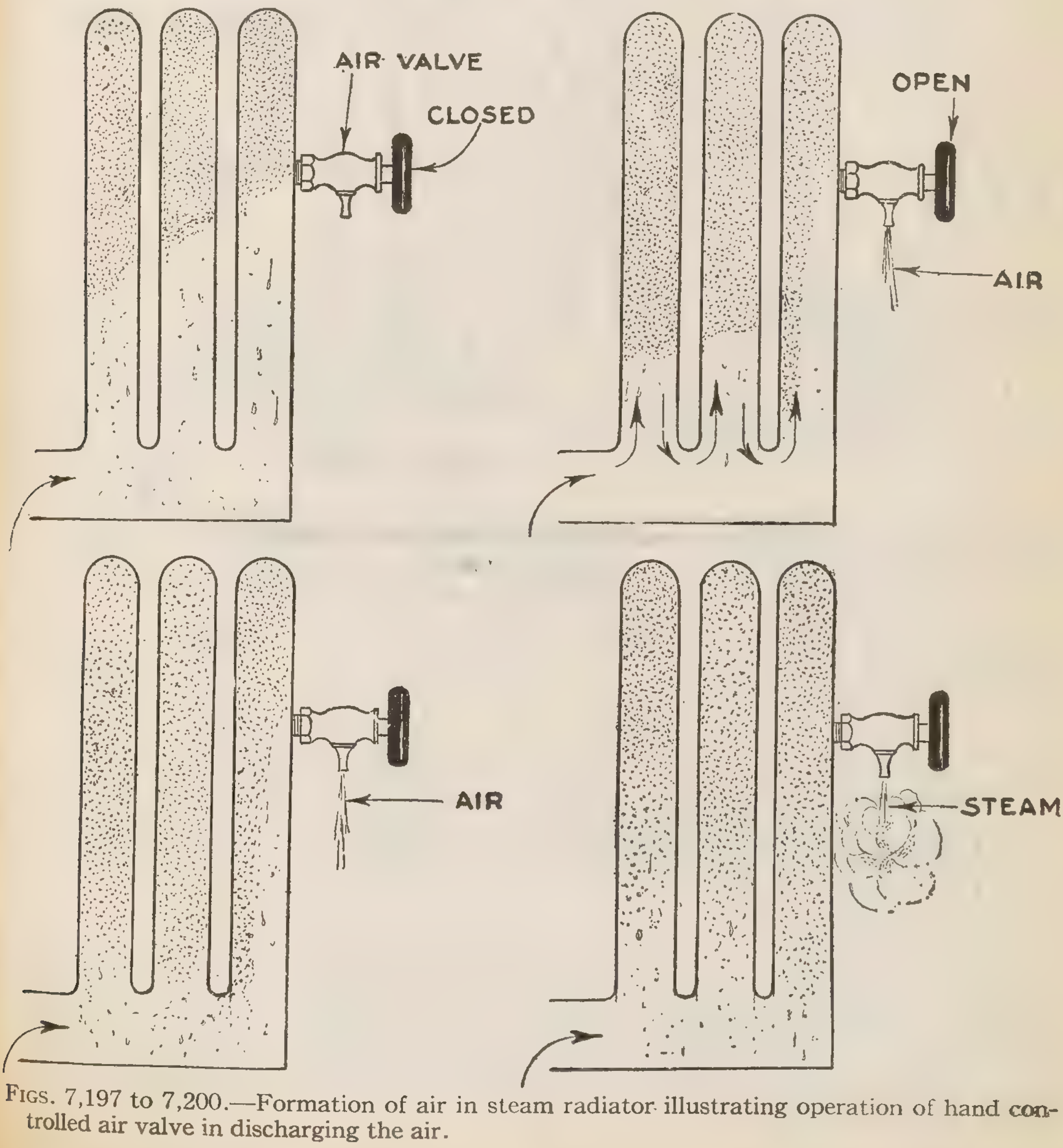


FIG. 7,196.—Powell compression radiator cock without stuffing box.



FIGS. 7,197 to 7,200.—Formation of air in steam radiator illustrating operation of hand controlled air valve in discharging the air.

There is a multiplicity of types of these valves. The duty to be performed is, *1, to open to expel air, and 2, to close when steam or water enters the valve.*

The principles generally employed to secure automatic

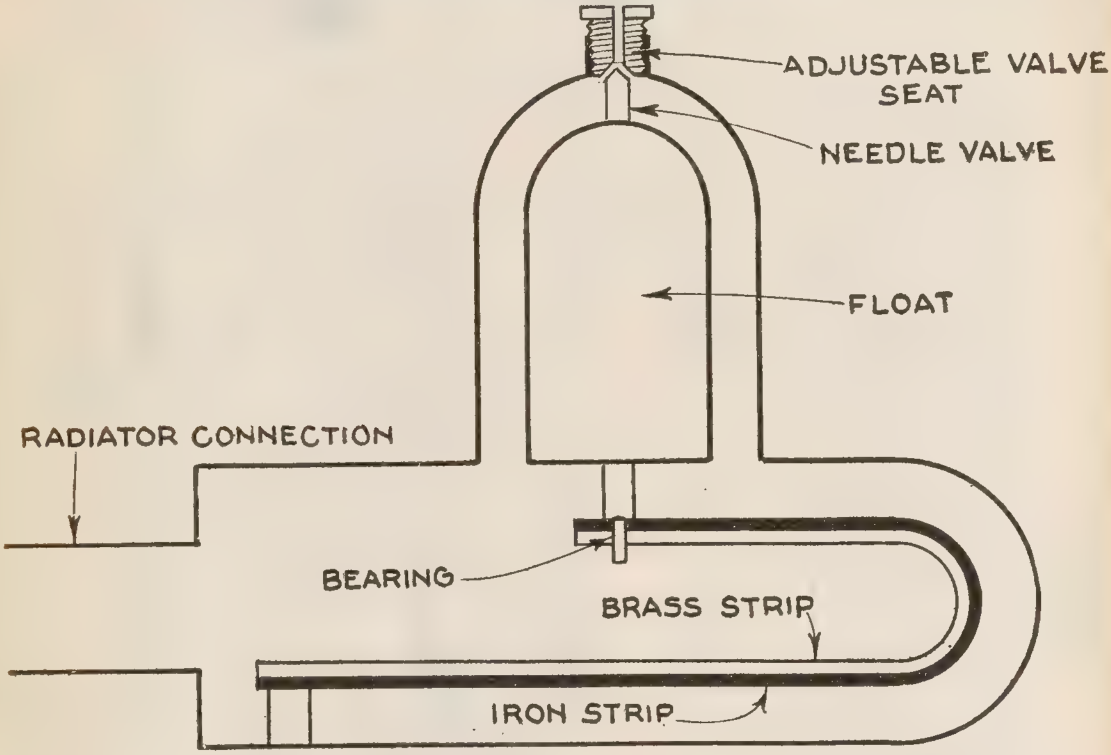


FIG. 7,201.—Elementary automatic radiator valve showing essentials necessary for automatic action.

actions are:

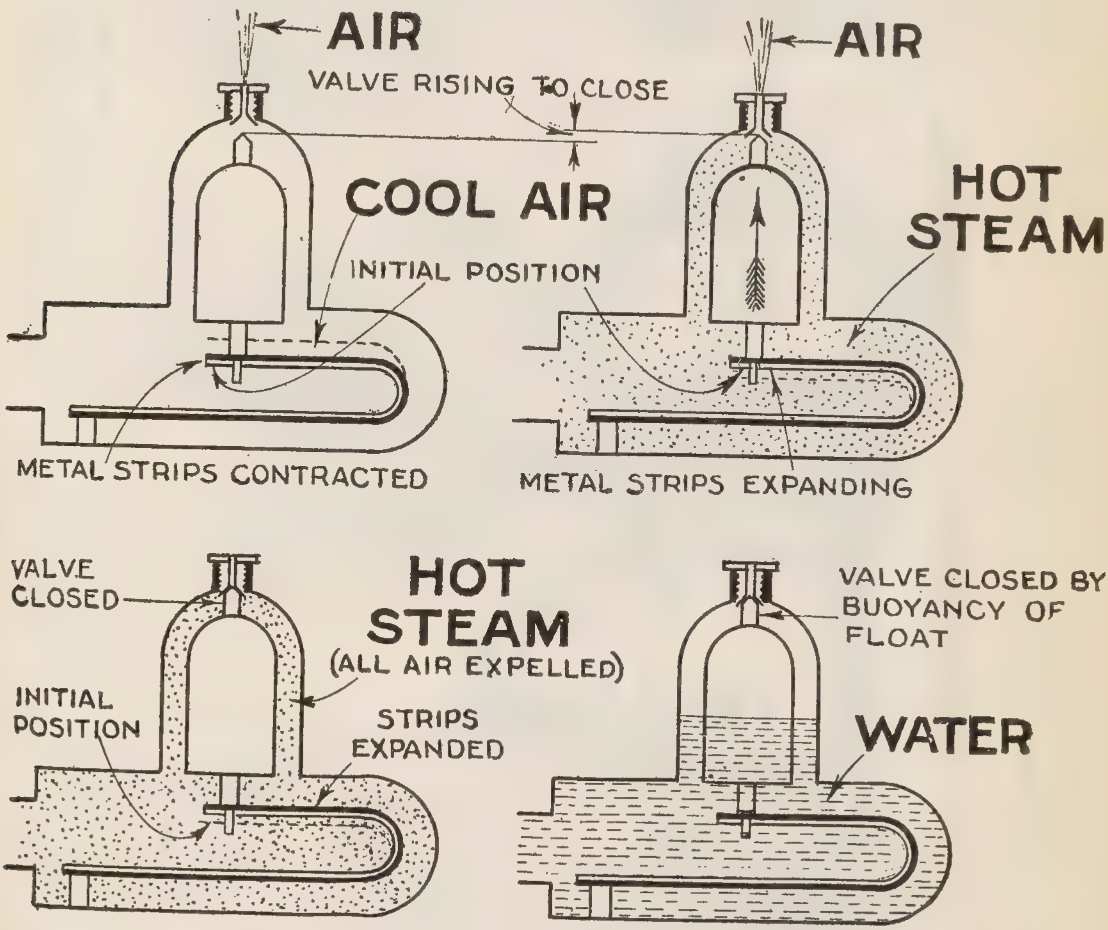
1. Expansion and contraction of metals.
2. Expansion and contraction of liquids.
3. Buoyancy or flotation.
4. Air expansion.

Fig. 7,201 shows the essentials of a typical valve operating on the principles generally employed and figs. 7,202 to 7,205 the operation of the valve as influenced by the presence of air, steam and water.

Some valves are provided with a ball check which acts in case of vacuum in the radiator to prevent the inrush of air.

Figs. 7,223 and 7,224 show the principle of operation of such device.

For additional information on air valves, see chapter on Heating and Ventilation.



FIGS. 7,202 to 7,205.—Operation of typical automatic air valve. ***In operation,*** when the relatively cold air is passing through the valve the metal strips lie in contracted position with legs close together, valve open allowing air to escape as in fig. 7,202. When steam enters, being at a higher temperature than the air causes the metal strips to expand. The brass strips expanding more than the iron strip causes the end which carries the valve spindle to rise to close as in fig. 7,203. When the strips are fully expanded the valve is closed, shutting off escape of steam as in fig. 7,204. In case the radiator become flooded with water, the latter entering will cause the float to push up the valve and prevent escape of water as in fig. 7,205.

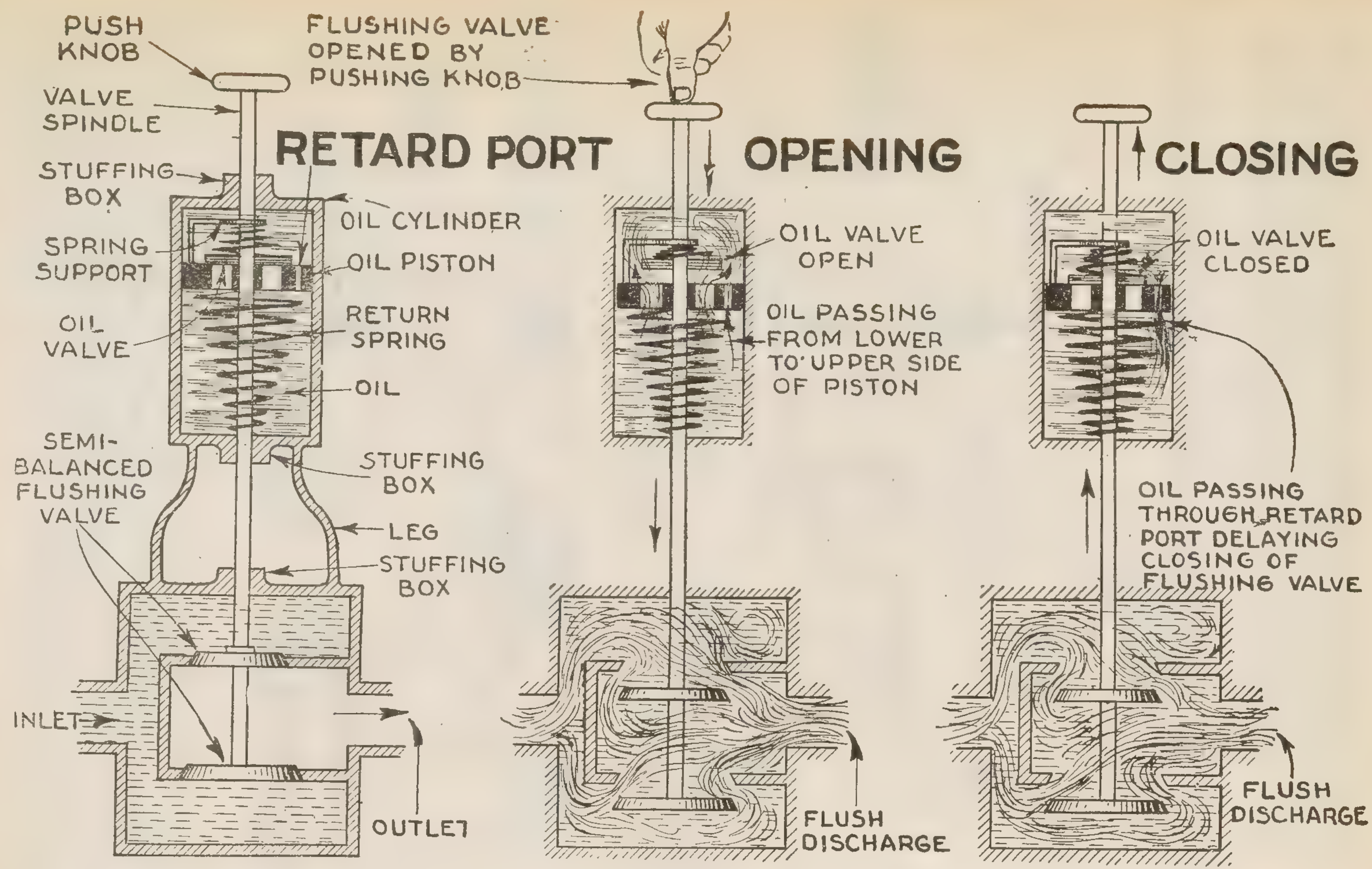


FIG. 7,206.—Elementary oil retarded flushing valve showing essential features.

FIGS. 7,207 and 7,208.—Operation of elementary oil retarded flushing valve. Fig. 7,207, valve being opened by depressing knob. During this movement the oil below the piston passes easily through the oil valve to the other side. When the knob is released; the oil valve, closes so that the only the small retard port is left for the oil to pass through the piston. This offers considerable resistance against the pressure of the spring acting to close the valve. Accordingly the valve closes very slowly, allowing time for ample discharge of water to properly flush the bowl.

Flush Valve. The function of a flush valve is to deliver just enough water to effectively flush the fixture which it serves. In modern building construction progressive architects, builders and owners realize that the flush valve, for the maximum service and economy of operation, is the proper device for flushing water closets and urinals.

The elementary valve shown in fig. 7,206 shows the essentials for applying this principle to a flushing valve, and figs. 7,207 and 7,208, the operation of the valve.

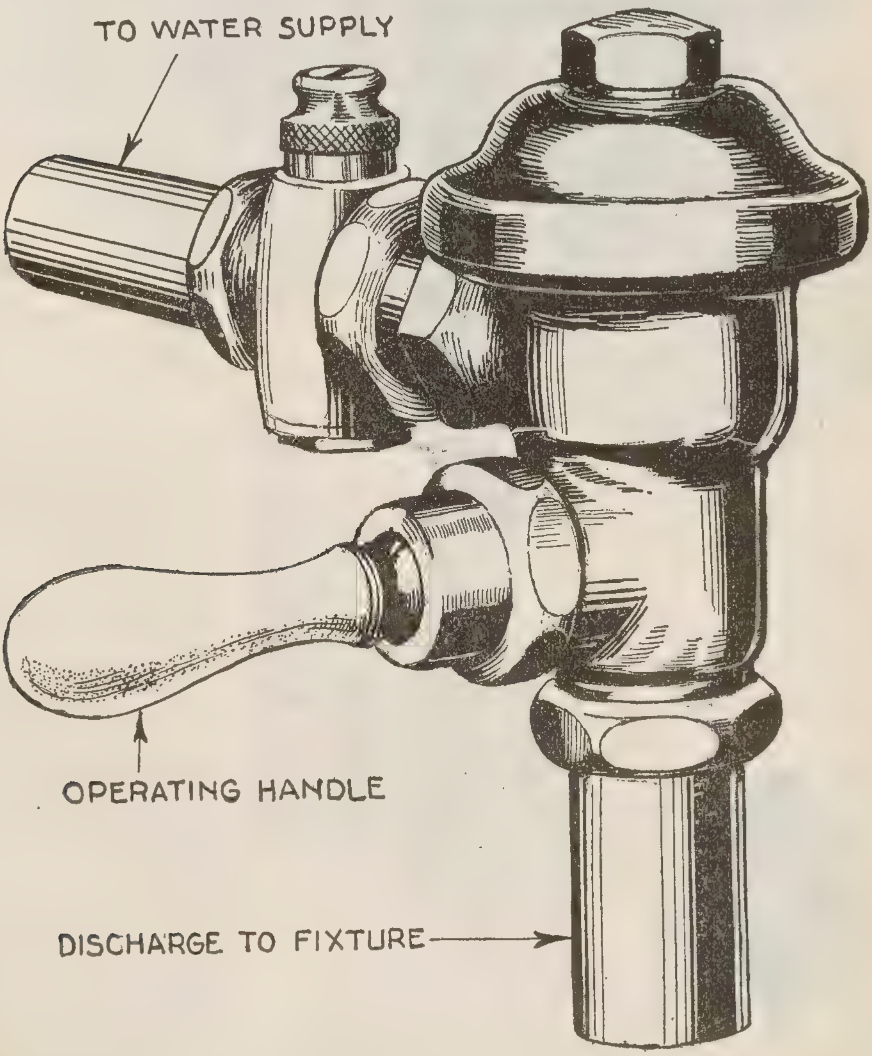
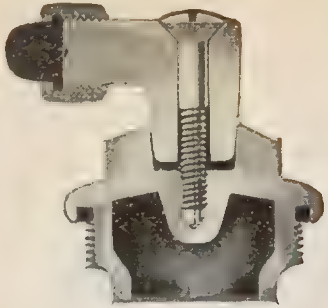
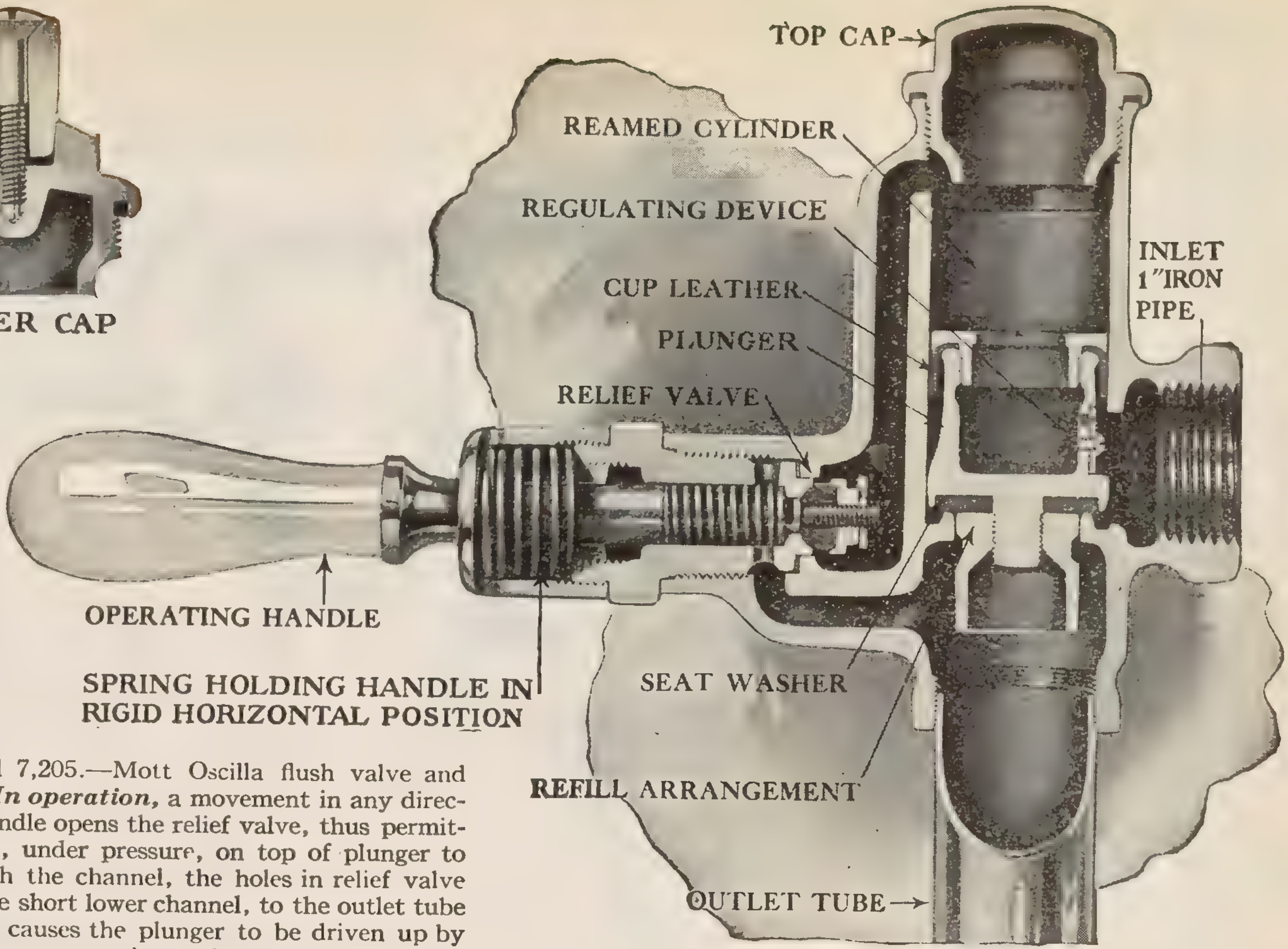
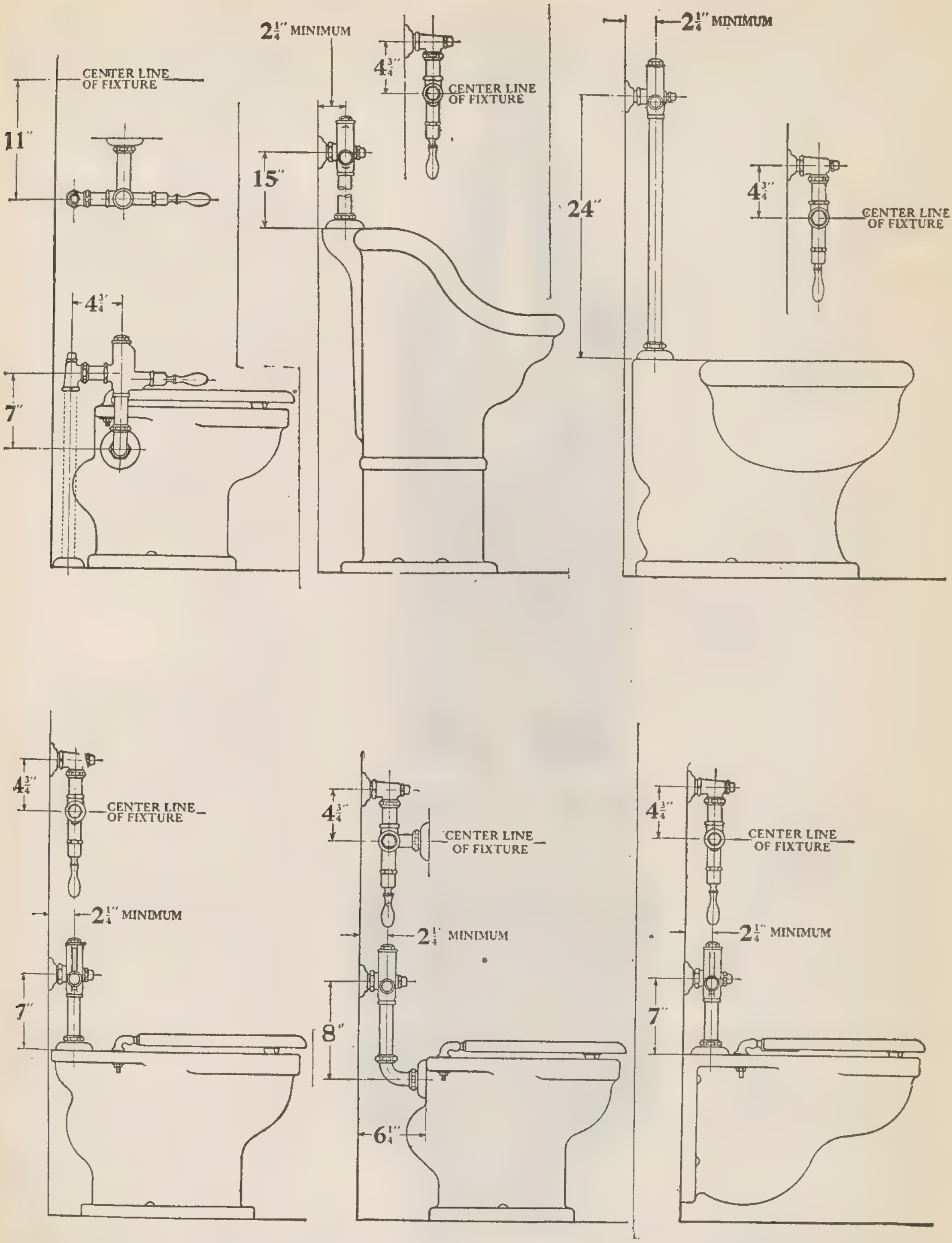


FIG. 7,209.—Sloan Royal flush valve. ***In construction,*** there is a diaphragm, preliminary, and main valves forming a complete unit and constituting the only moving part.





FIGS. 7,202 and 7,205.—Mott Oscilla flush valve and bumper cap. ***In operation,*** a movement in any direction of the handle opens the relief valve, thus permitting the water, under pressure, on top of plunger to escape through the channel, the holes in relief valve section and the short lower channel, to the outlet tube of valve. This causes the plunger to be driven up by the water pressure, engaging under cup leather, thus opening a free passage for water from supply line to outlet of valve. A small amount of water, depending upon the size of orifice set by device on side of plunger, is diverted to top of plunger, filling the upper part of the valve chamber and by reason of the greater area of plunger top this accumulation of water under pressure forces the plunger to descend to its seat. The duration of this process is determined by the setting of the regulating device. A large opening through the by pass allows water to fill upper chamber quickly, hence a rapid descent of plunger and consequent short flush. Setting regulating device to a smaller opening reverses the action.



FIGS. 7,212 to 7,217.—Roughing in measurements showing various connections of Mott Oscilla flush valve.

In principle, flush valves *are opened by hand and closed automatically, an adjustable retarding element being provided so the valve will close slowly, the closing period being so timed as to permit the required amount of water to discharge into the fixture which it serves.*

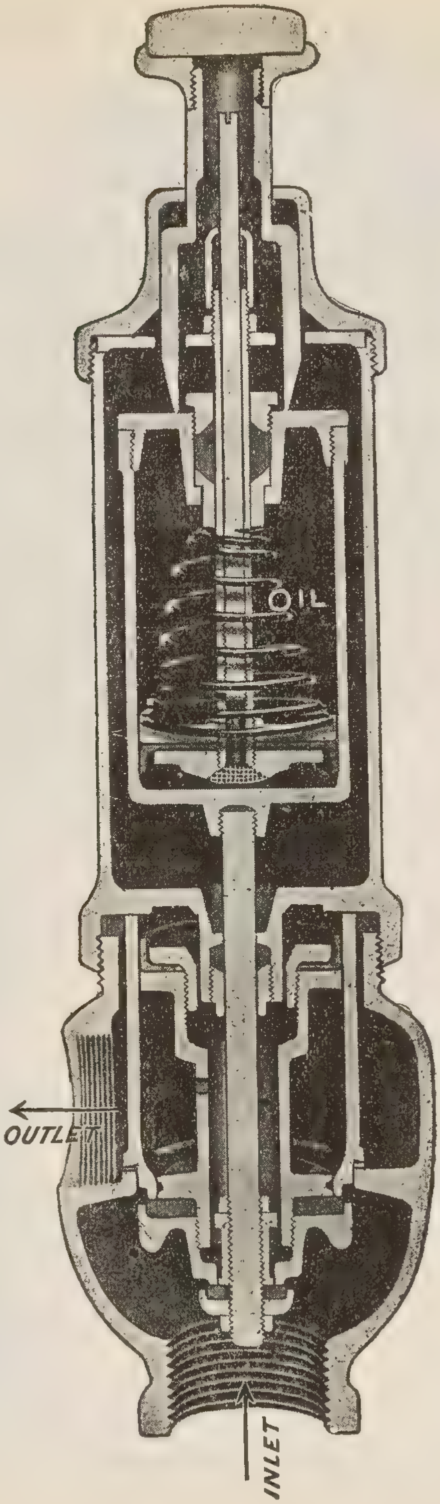
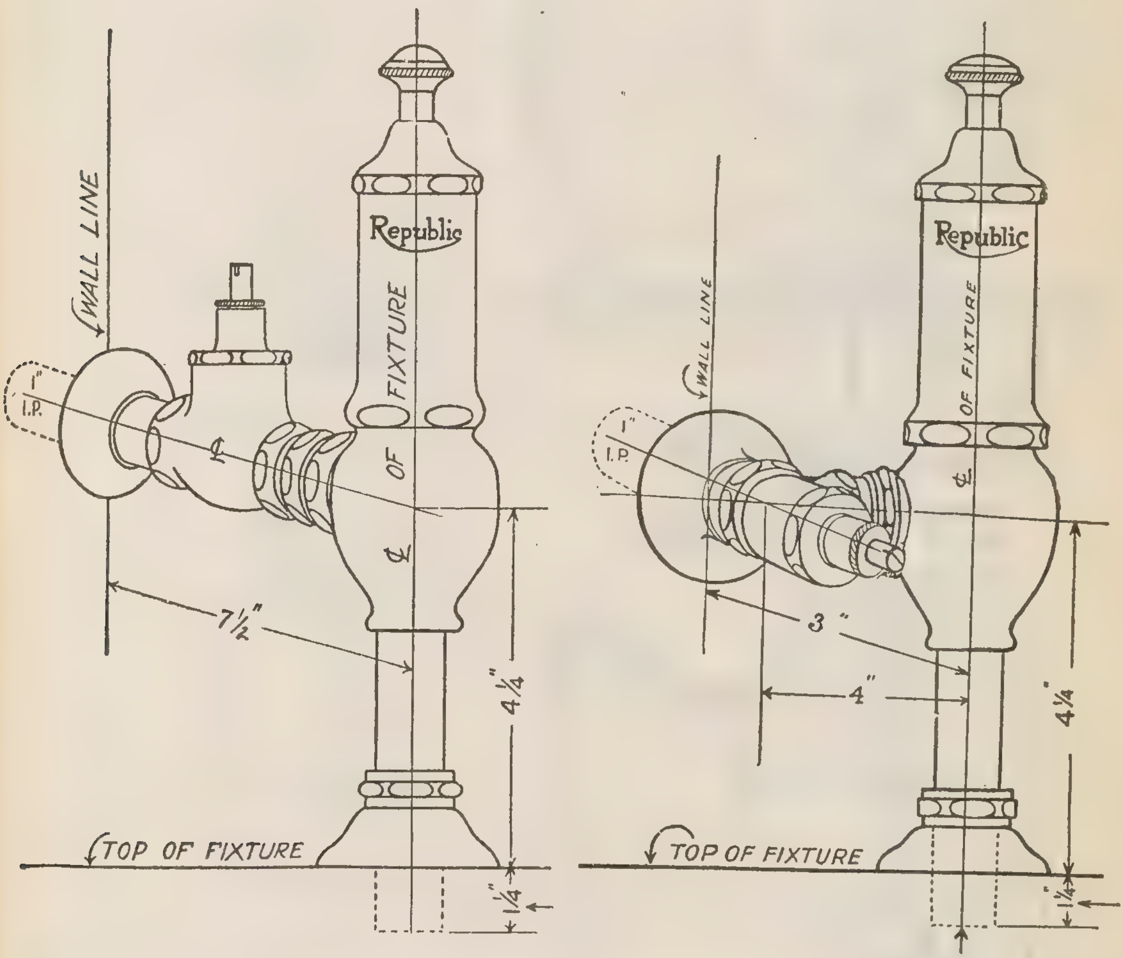


FIG. 7,218.—Republic oil regulated flush valve. ***In operation,*** the oil is forced from one side of the piston to the other, and the valve can only close as the oil passes back through a small opening or by pass. The duration of the flush is determined by the size of the opening through which the oil passes and is regulated from the outside of the valve. Mineral oil is used and since it cannot escape from the chamber, it will not need replenishing.

NOTE.—The possibility that the house system of water supply may be contaminated from the water closet if the water supply be directly connected to the water closet fixture, should not be overlooked. Although this contamination is more likely to take place in the operation of the older types of closets, such as the pan closet and the plunger type, it is not of rare occurrence in connection with later types, especially the so called frost proof fixture. If the pressure be materially lowered in the street main by accident or otherwise, it sometimes happens that water may be drawn back into the house system by siphonage from a water closet or like fixture, thus of course incurring the possibility that germs of disease may be brought into the water supply used for domestic purposes. The use of a tank into which the water is first drawn, obviates this danger.—*Gray.*

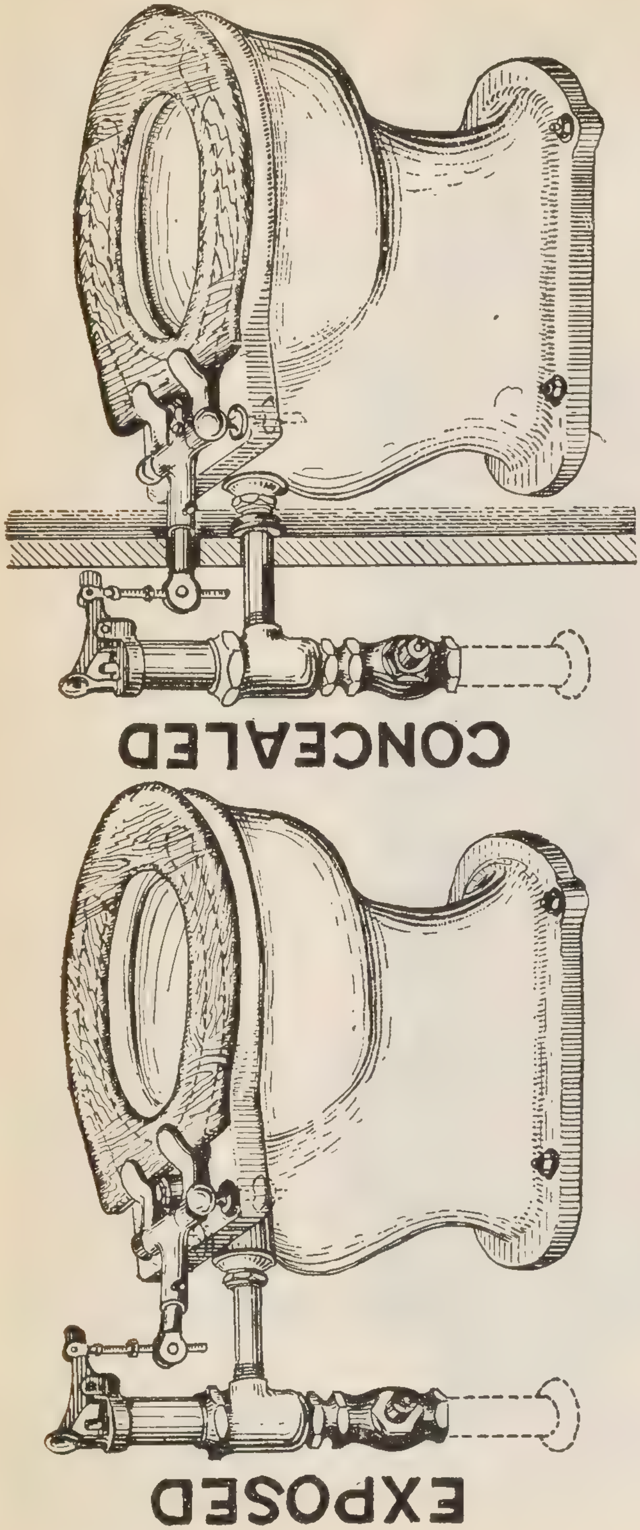
Since in operation, a predetermined amount of water is delivered, the installation of flush valves eliminates the personal equation and insures that the fixture receives always an adequate charge of flushing water. Flush valves of the different manufacturers have various means of controlling the regulation.



FIGS. 7,219 and 7,220.—Roughing in measurements for two patterns of Republic oil regulated flush valve.

By the use of a flushing valve, the flushing tank may be dispensed with.

The object of the valve is not so much to eliminate the tank as to insure proper flushing especially in public toilets where the average user, not liable for the expense of maintaining the



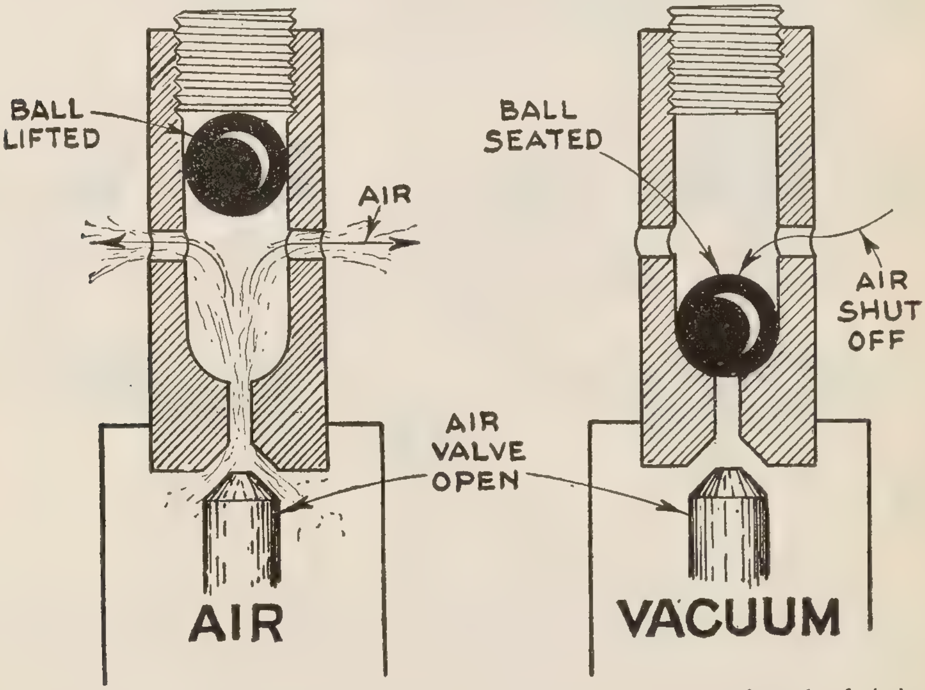
FIGS. 7,221 and 7,222.—Seat operated type of Republic flush valve showing method of attaching control transmission to fixture. Fig. 7,221, exposed; fig. 7,222, concealed.

plumbing in working order, cares little whether or not the flushing be adequate to clear the bowl; this is important especially because of the extra time required to flush syphon type closets.

In the selection of mechanical devices of this kind, which are permanently installed in buildings where they receive considerable usage, too much care cannot be exercised in having their construction such that the replacement of wearing parts can be inexpensively and easily made.

NOTE.—***Flush valves*** can be used on plumbing fixtures of any manufacture and they are especially desirable in public toilets, because an adequate supply of flushing water is obtained, whereas with non-automatic valves, a considerable number of users will not take the time to hold the valve open long enough for a full flush, consequently there is the possibility of the fixture becoming clogged and overflowing.

Pressure Reducing or Regulating Valve.—There are necessary cases where it is desired to have the pressure on a branch line less than on the main line, as for instance where the water supply is taken from city main under a pressure considered too high for an old installation of lead piping. In such case, in the absence of a tank in the attic, a reducing valve may be used. This type of valve *is a spring or lever loaded valve similar to a*



FIGS. 7,223 and 7,224.—Operation of ball check on air valve to prevent inrush of air in case of formation of vacuum inside radiator. Fig. 7,223, check open, air escaping; fig. 7,224, air expelled and vacuum in radiator, check closed preventing air entering radiator.

safety valve which in operation remains open until the pressure rises to a predetermined value when it closes, opening again as soon as the pressure begins to diminish.

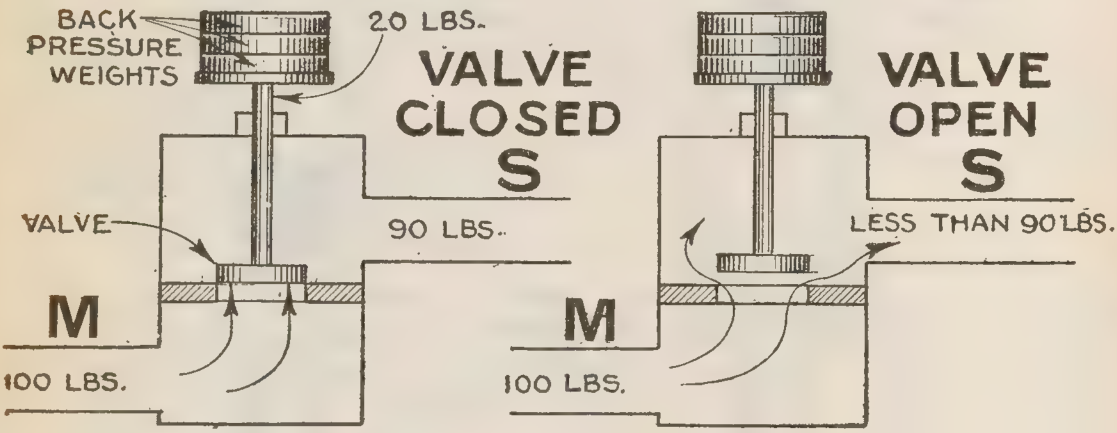
The operation of the valve is shown in the elementary illustrations figs. 7,225 and 7,226.

To illustrate the conditions of equilibrium assume that the valve just covers the opening, that is, area valve = area opening through seat = say 2 sq. ins.

Now, if valve be loaded with say 20 lbs. (including weight of valve and stem) as shown in fig. 7,225, this will be equivalent to $20 \div 2 = 10$ lbs. per sq. in. Accordingly if say 100 lbs. pressure (per sq. in.) be applied to the valve through main pipe M, it will have acting against it the 10 lbs. per sq. in. due to the loaded valve, hence when the pressure above the valve and in line S, rises to $100 - 10 = 90$ lbs. per sq. in., the valve will close; that is, the pressure cannot rise higher than 90 lbs.

If now, a valve be opened on line from S, the pressure will fall and valve will immediately open to make up for the reduction in pressure, closing again when equilibrium is re-established as in fig. 7,225.

Theoretically, if there were no friction, the pressure in S, would remain practically constant, and if there were neither friction nor inertia, the pres-



FIGS. 7,225 and 7,226.—Elementary reducing valve illustrating working principle. The illustration shows a valve loaded with weights carried directly on the end of the valve stem. Assume that the total downward pressure of the valve on its seat.

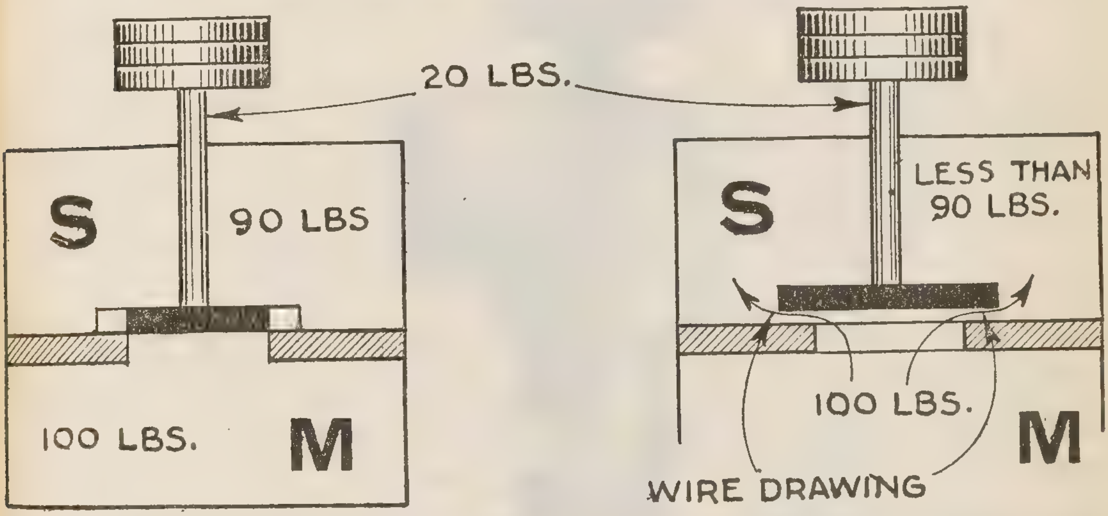
sure would remain constant. Such conditions of course are not possible in practice, there is always friction of the many parts and friction of the liquid or gas passing through the valve; moreover, the area of the valve of the type shown must always be greater than the opening or *port*, otherwise there would be no *seal* and consequently more or less leakage. This modifies the conditions of operation and the plumber wishing to increase his knowledge and especially the steam fitter who wonders *why a pop safety valve "pops"* will study carefully the explanation here given and as presented more in detail under safety valves.

In figs. 7,227 and 7,228, assume the valve to be of greater diameter than the port. Let area valve = 3 sq. ins.; area of port 2 sq. ins. as before. Now when the valve is closed as in fig. 7,227, evidently the area exposed to the pressure below the valve = area of port = 2 sq. ins. (indicated in solid black).

Now with the conditions as shown in fig. 7,227, the valve is in equilibrium, that is just on the point of opening.

If the 90 lb. pressure above the valve be reduced the valve will open, more or less depending on the amount of reduction of pressure in the upper chamber.

As soon as the valve leaves its seat its entire area (3 sq. in.) is presented to the pressure below it. The liquid or gas flowing out between the valve and seat due to the extremely thin or restricted passageway here presented will flow at enormous velocity and the friction or resistance to flow thus produced helps to keep up the pressure; that is, starting with the initial pressure and gradually falling while traversing the passage between the



FIGS. 7,227 and 7,228.—Elementary reducing valve with excess area or *seal* illustrating *wire-drawing* and its effect on the regulation of pressure.

valve and seat this is known as *wire drawing*. The mean pressure on this excess area being less than the pressure in the lower chamber M, and greater than the pressure in the upper chamber S. Accordingly the valve will remain open until the pressure in S, builds up to a value in excess of the pressure at which the valve opened.

Thus in fig. 7,228, assume that the pressure acting on the valve area directly above the port be 100 lbs. per sq. in. and the mean pressure acting on the excess area, be 97 lbs. per sq. in. then total pressure tending to hold valve open is

$$
\begin{array}{lr}
 & 100\times 2 = 200 \text{ lbs.} \\
 & 97\times 1 = 97 \text{ lbs.} \\
\hline
\text{Total,} & 297 \text{ lbs.}
\end{array}
$$

this is equal to $297 \div 3 = 99$ lbs. per sq. in.

The pressure tending to close valve due to load is

$$20 \div 3 = 6.67 \text{ lbs. per sq. in.}$$

Accordingly, pressure in S, necessary to close valve is

$$99 - 6.67 = 92\tfrac{1}{3} \text{ lbs.}$$

that is, assuming the pressure in M, to remain constant, the pressure in S, must build up to an excess of $92\frac{1}{3} - 90 = 2\frac{1}{3}$ lbs. per sq. in. to close the valve.

Relief Valve.—This is *an escape or form of safety valve* fitted

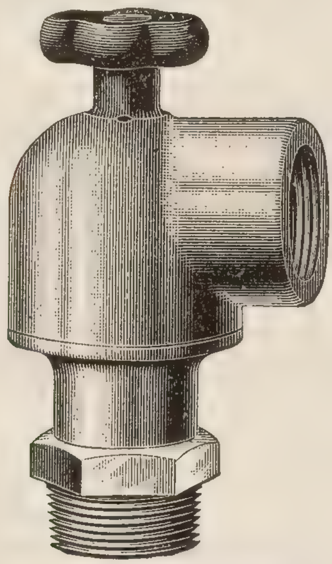


FIG. 7,229.—Powell water relief valve is designed for the purpose of giving instant and automatic relief to water chambers in waterworks, steam pumps and steam engine cylinders, or wherever a positive automatic relief is required. The entire valve is made of brass steam metal, finished. It is made with male or female thread, or with any size flange cast on body of valve. It is also made to screw into iron flange, and has on top a hand wheel to regulate the pressure.

NOTE.—***The purpose of a relief valve*** is to prevent the development of abnormal over-pressure in the cylinder, tank, or other vessel to which it is attached. Its function is exclusively that of a safety device and it should not be confounded with a pressure reducing valve or other device intended to regulate or control the flow pressure. Although a relatively simple and inexpensive device in itself, the relief valve plays an important part in the promotion of uninterrupted service and the prevention of damage to life and property. Its application to cylinders of steam engines, pumps, compressors and other reciprocating units is a virtual necessity as it affords the most practical and safest method of caring for slugs of condensation or priming charges, never wholly preventable in even the most approved installations. The selection of a protective device of this nature warrants careful consideration of its design and construction, and a thorough investigation of its adaptability to the particular requirements of the specific class of service for which it is to be used.

to feed pumps on steam engines, or other water lines subject to sudden excess pressure above the safe working pressure. Feed pump lines having check and globe valves should always be provided with a relief valve. Although a relief valve is virtually a form of safety valve it should not be confused with the latter as the two valves are intended to perform different service.

The standard form of relief valve, one pattern of which is shown on fig. 7,229 has a male thread on the inlet and a female thread on the outlet. Note the hand wheel on top to regulate the relief pressure.

Safety Valve.—This is the most important device fitted to a boiler, as it prevents the steam rising above the safe working pressure, that is, the pressure at which it should be set. Moreover, upon its proper operation depends the safety of those in charge of the boiler.

A good safety valve should be: 1, large enough in diameter, and have sufficient *lift* to allow the steam to escape as fast as it is generated, when the pressure is slightly above that to which it is set; 2, it should close as soon as the pressure has dropped a predetermined amount below the set pressure; 3, it should be enclosed or so protected that it cannot be tampered with or accidentally interfered with by contact with foreign objects; 4, for marine purposes it must be so constructed as not to be affected by the motion of the boat.

With respect to the valve proper there are several types of safety valve, as those having:

1. Plain valve with seat having flat contact surface;
2. Plain valve with seat having beveled contact service;
3. "Pop" valve with seat having either flat or beveled contact surface.

Of the three types, the latter with beveled contact surface is

generally used for marine use.

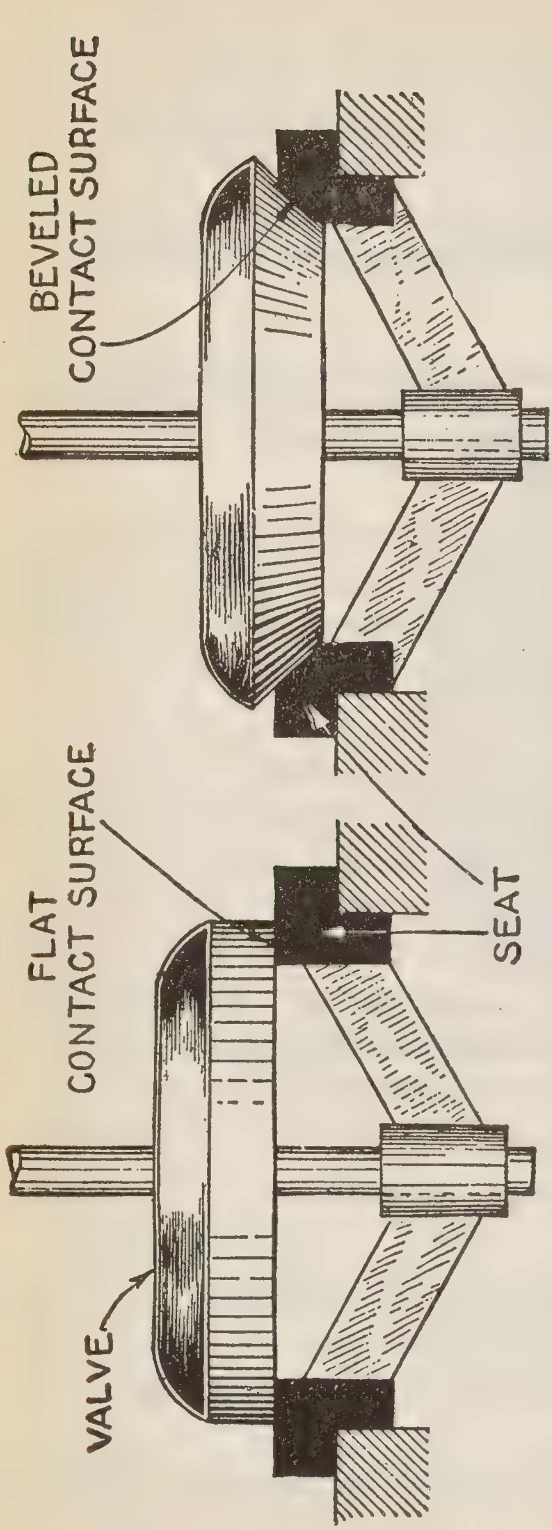
Figs. 7,230 and 7,231 show flat and beveled contact surfaces.

The discharge capacity of a flat valve is 1.41 times that of a 45° beveled valve of same diameter and lift.

With respect to the method of loading the valve, or application and nature of the holding down force, safety valves are divided into four general classes:

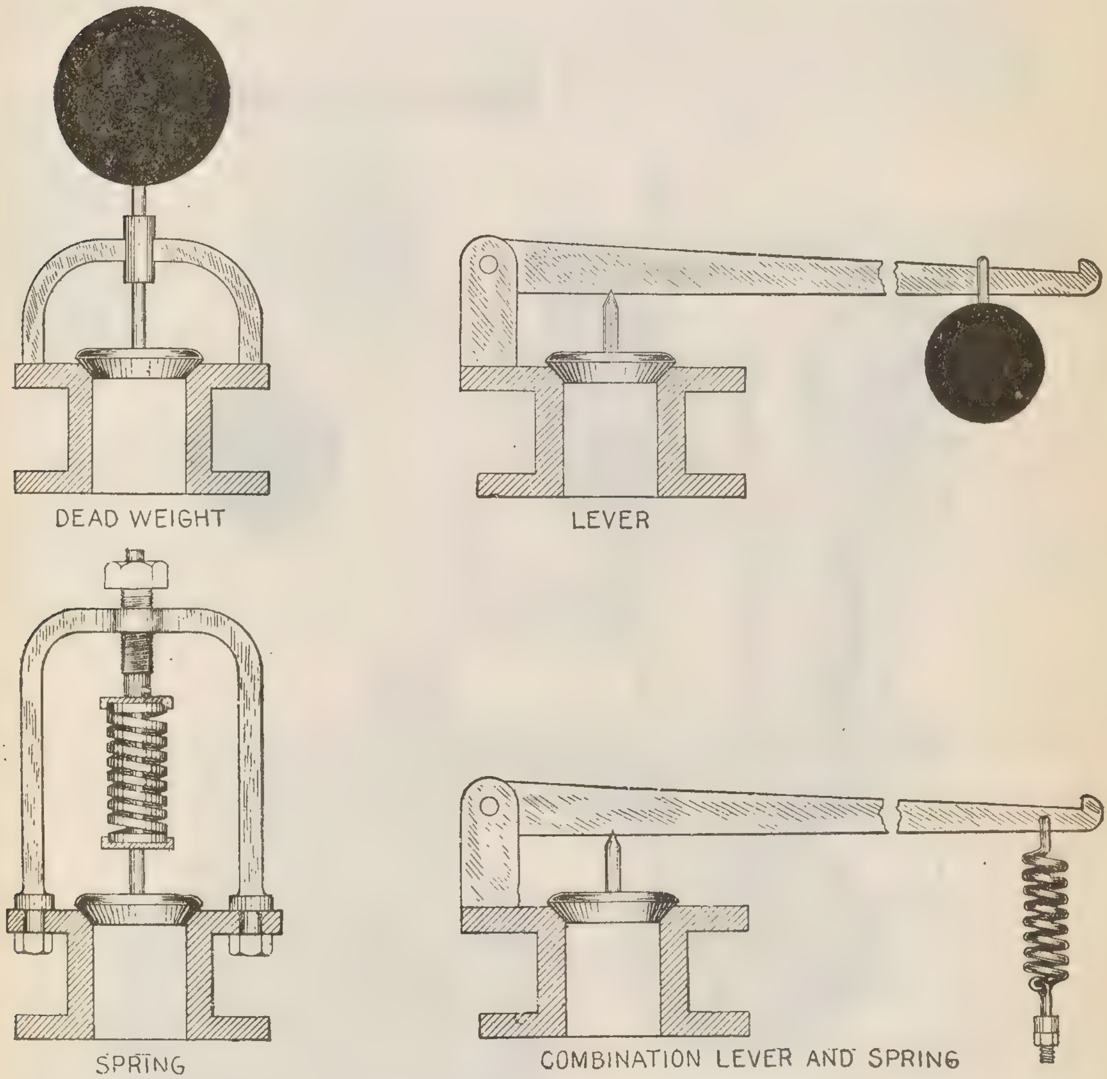
1. Dead weight.
2. Lever.
3. Spring.
4. Combination lever and spring.

The distinction between these different classes is shown in figs. 7,232 to 7,235.



Figs. 7,230 and 7,231.—Valve and seat with flat and beveled contact surface. ***For marine use*** the beveled type is the standard and the bevel must be inclined at an angle of 45°. Most engineers think that flat seats are not allowed for marine use, but this is not correct, for according to Rule II, 23—Flat seat safety valves may be used under the formula and table under the heading "Safety Valves" in Rule II.

Dead Weight Safety Valve.—This consists of *a valve and stem loaded with a weight placed* ***directly*** *on the stem*, there being



Figs. 7,232 to 7,235.—Elementary safety valves showing various types. Fig. 7,232, dead weight valve;. fig. 7,233, lever valve; fig. 7,235, spring valve; fig. 7,235, combination lever and spring valve;

a guide through which the stem works as the valve opens and closes.

Evidently this type of valve is suitable only for low pressure such as carried on steam heating boilers, otherwise the weight, especially in the case of large va.ves would assume enormous proportions as illustrated in the example following:

Example.—What dead weight must be placed on a dead weight safety valve having 4 sq. ins. valve area to blow at 5 lbs. steam pressure? What weight is required to blow at 100 lbs.?

Weight to blow at 5 lbs. $=4\times5 = 20$ lbs.
" " " " 100 " $=4\times100=400$ lbs.

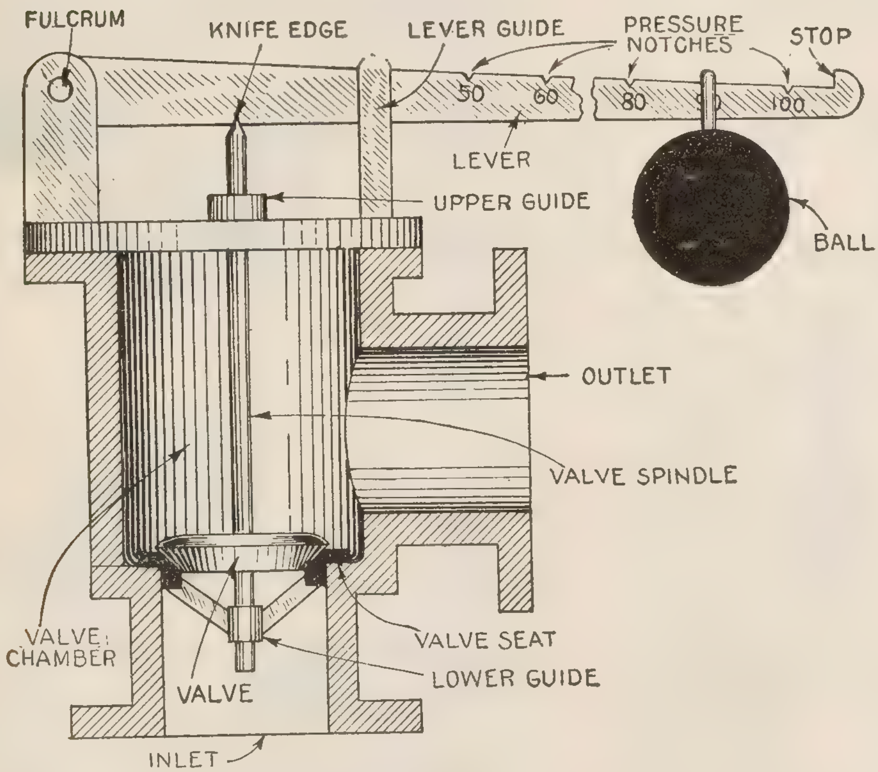
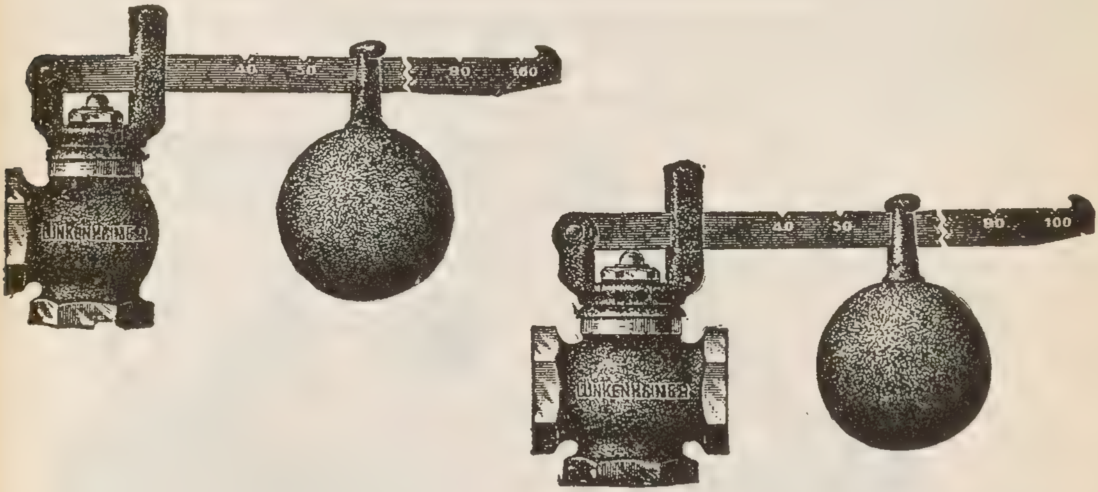


FIG. 7,236.—Sectional view of a lever safety valve showing essential parts.

Lever Safety Valve.—The essential parts of a lever valve as shown in fig. 7,236 consist of: 1, a valve chamber containing the valve seat, inlet and outlet opening; 2, a cover containing the upper spindle and lever guides, also an arm having a pivot hole at its end forming the *fulcrum;* 3, a *valve* and *spindle*, the latter

being attached to the valve and the projecting part terminating in a *knife edge;* 4, a *lever*, pivoted at one end to the projecting arm or *fulcrum*, in contact with the knife edge of the



Figs.7,237 and 7,238.—Lunkenheimer lever safety valves with screw ends. Fig. 7,237 angle valve; fig. 7,238, cross valve.

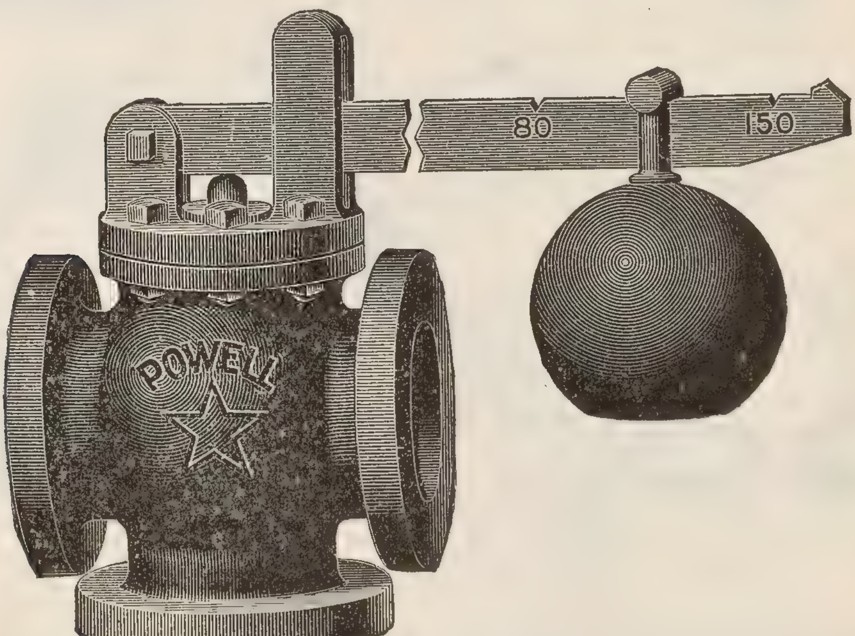
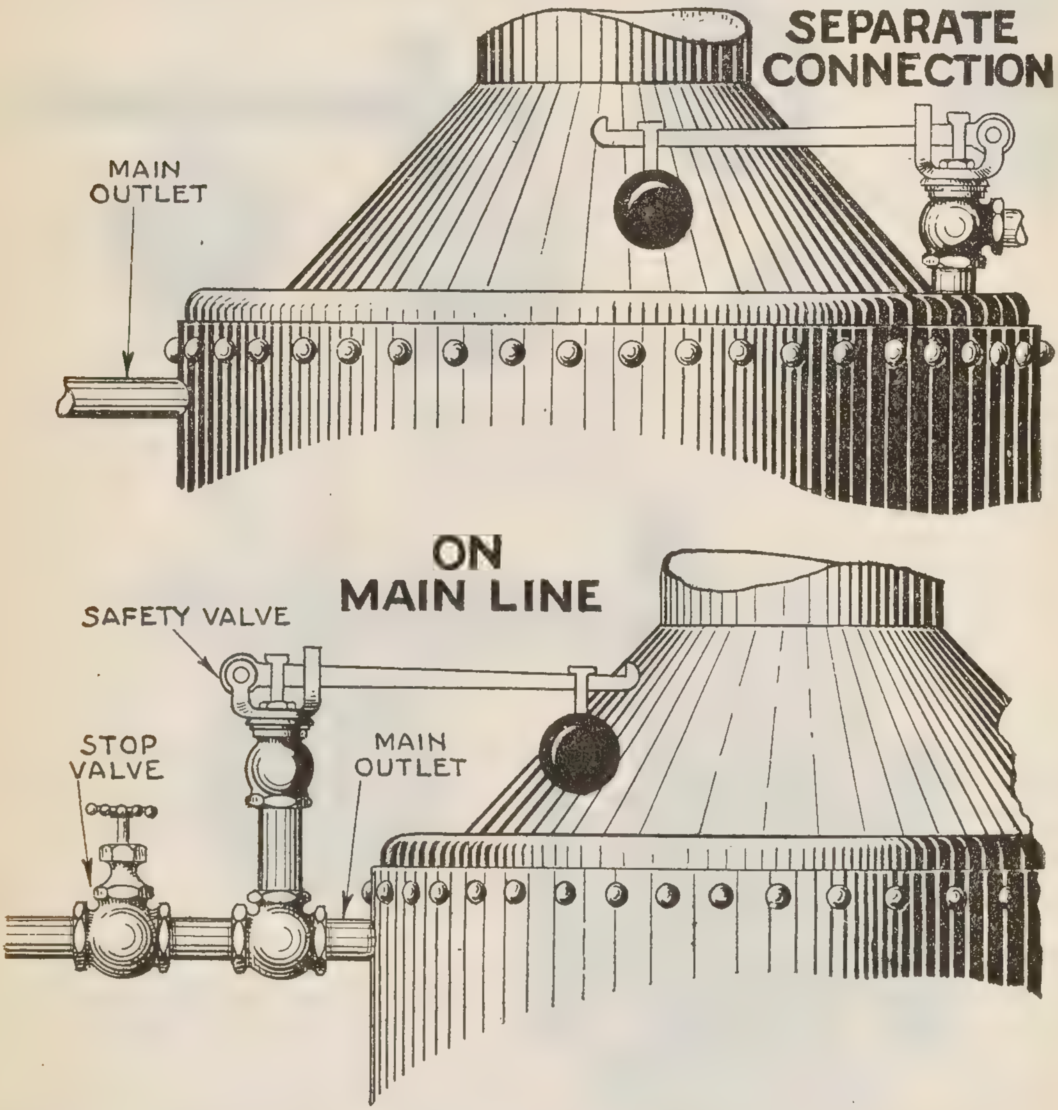


Fig. 7,239.—Powel iron body cross lever safety valve with bronze trimmings; sectional view showing construction.

spindle at an intermediate point and weighted at the other end with a *ball*.

In attaching any type of safety valve to a boiler it should preferably be attached to a separate outlet as shown in fig. 7,240 so that in case the valve blow while steam is being used on the main line, there will not be an unduly large discharge of steam from a single outlet which would tend to raise the water level and carry over water with the steam.

In case there be only one main outlet, and especially if this outlet be



FIGS. 7,240 and 7,241.—Place ment of safety valve. It should preferably be piped to a separate outlet as in fig. 7,240, but when placed on the main line it should be next to the boiler, that is, *there should be no valve* between the safety valve and boiler.

provided with a dry pipe or *collector* such as shown in fig. 7,242,* the safety valve may be attached to a tee on main steam pipe, as close to the boiler as possible ***without** any kind of valve between it and the boiler*. As shown in fig. 7,241.

An objection to the lever valve for marine use on vessels navigating rough water is that *the inertia of the weight produces*

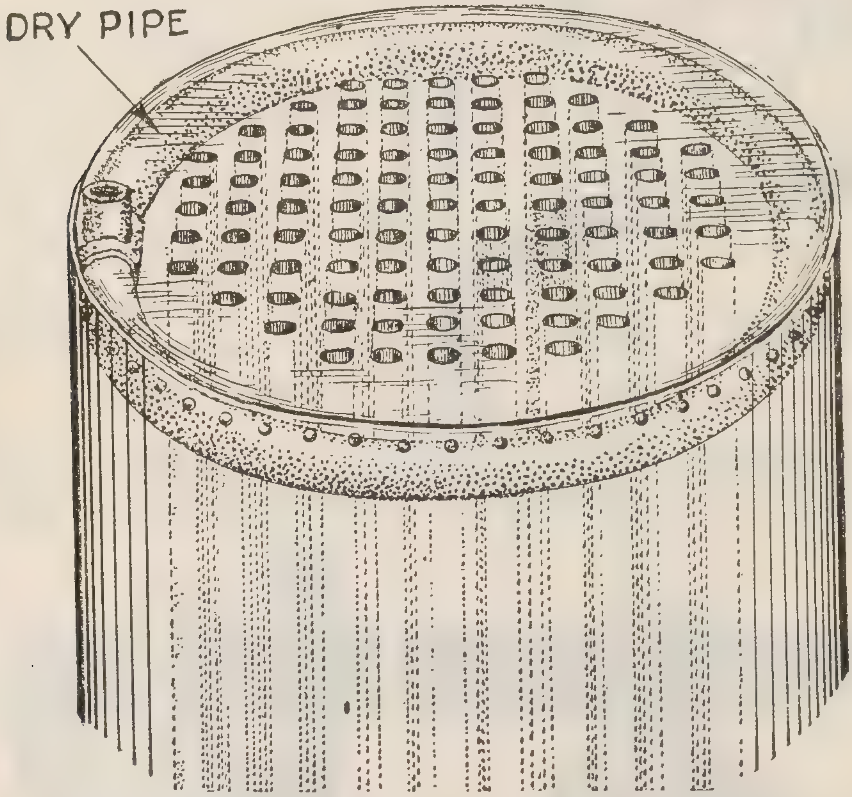
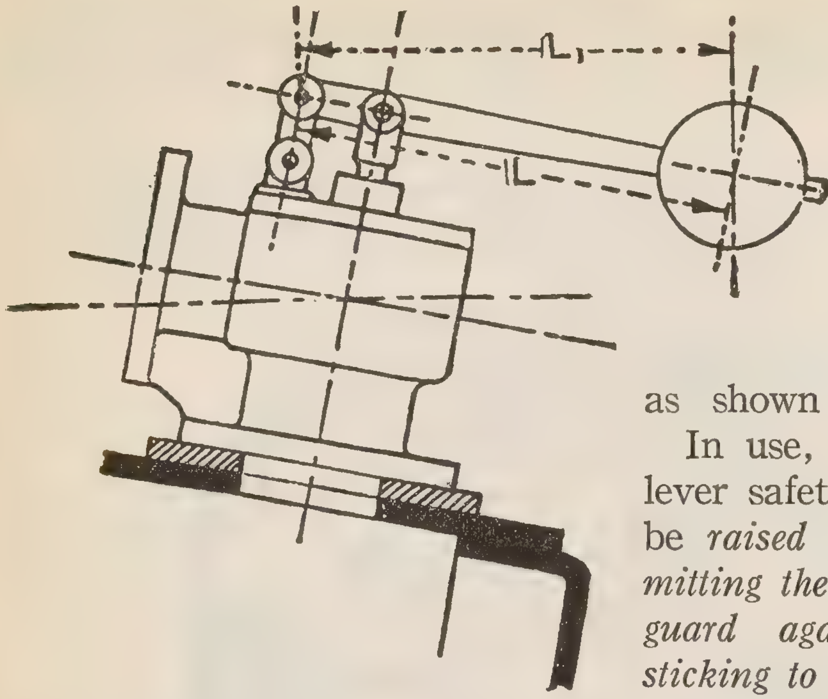


FIG. 7,242.—Author's dry pipe arranged to collect steam around the entire circumference of shell, thus permitting a high water level to protect the tubes, and increase the efficiency of the heating surface while insuring dry or practically dry steam and protection from priming on sudden heavy demand for steam.

a variable pressure on the valve tending to close and open the valve respectively with rise and fall of the boat on the waves. Moreover, when the boat rocks, the horizontal position of the lever is disturbed and the blowing pressure of the valve is lowered

*NOTE.—For the complete design of the boiler fitted with the *collector* shown in fig. 7,242, see the Author's Engineers' and Mechanics' Guide, No. 6, Chapter 71 on "How to Design a Boiler."



as shown in fig. 7,243.

In use, the lever of a lever safety valve should be *raised* **frequently** *permitting the valve to blow to guard against the valve sticking to the seat.*

FIG. 7,243.—Diagram of a lever safety valve, showing decrease of the weight's effect, as the result of incline in a heavy sea. In the diagram, L, is the length of the lever arm, the full length being effective when horizontal but when inclined the effective length is reduced to L_1.

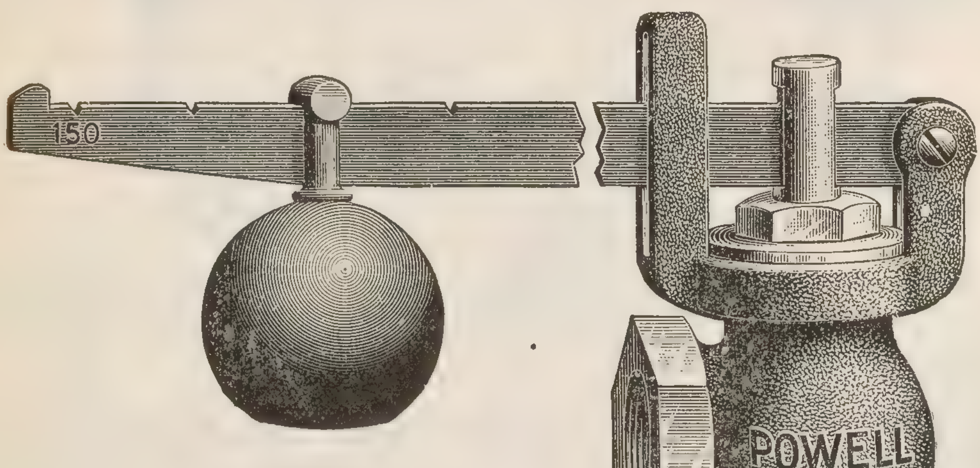


FIG. 7,244.—Powell steam bronze angle pattern lever safety valve with screwed ends for working pressures up to 150 lbs. Showing exterior construction.

Spring Safety Valve.—In this type of valve, the force due to the compression of a spring is used to oppose the steam pressure instead of a weighted lever.

The essentials of the spring valve are shown in fig. 7,245.

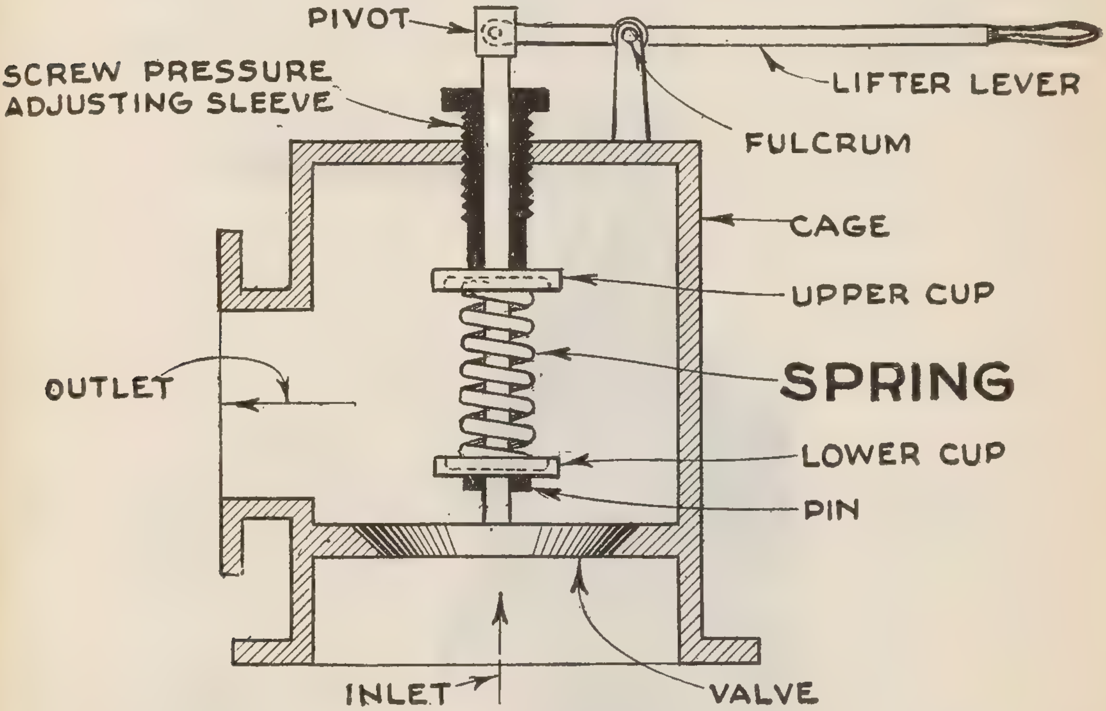


FIG. 7,245.—Elementary spring safety valve showing essential parts with exception of the "popping" attachment provided on the "pop" type of spring valve.

FIGS. 7,246 and 7,247.—American springs for brass and iron pop safety valves. Fig. 7,246, round type for brass valves 2 inches and under; fig. 4,693, rectangular type for brass and iron valves 2½ inches and over.

The appearance of two types of spring used is shown in figs. 7,246 and 7,247.

The elementary spring valve shown in fig. 7,245 is not provided with the "pop" feature common to most spring valves. Valves having this feature are called pop safety valves.

By definition, a pop safety valve is one so constructed that

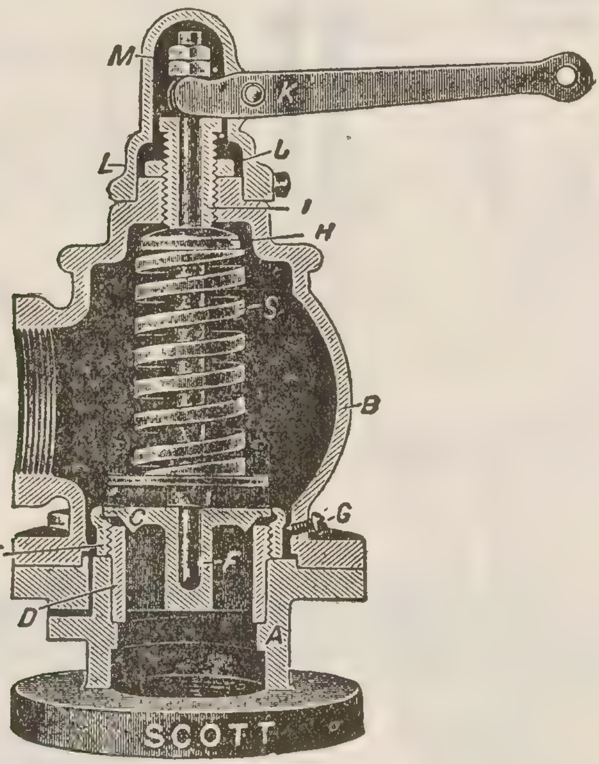
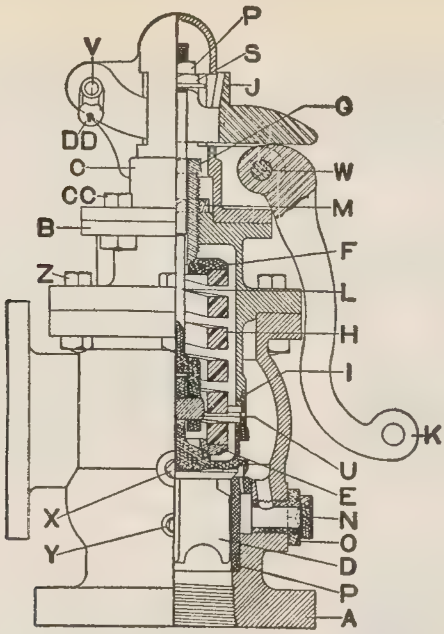


FIG. 7,248.—Scott spring pop safety valve. ***The parts are:*** A, base; B, iron case; C, bronze valve or disc; D, bronze bushing or seat; E, adjustable ring; F, steel stem and spindle; G, screw to hold adjustable ring; H, spring plate; I, bronze loading bolt; J, lock nut; K, lever (malleable iron); L, iron cap and screw to hold cap; M, stem or lifting nuts.

it opens very suddenly like a cork popping out of a champagne bottle and remains open until the pressure is reduced a predetermined amount.

The principle upon which this operation depends, is *the presentation of an **excess area** of valve at the instant the valve leaves it seat and **before** its opens to the atmosphere.*



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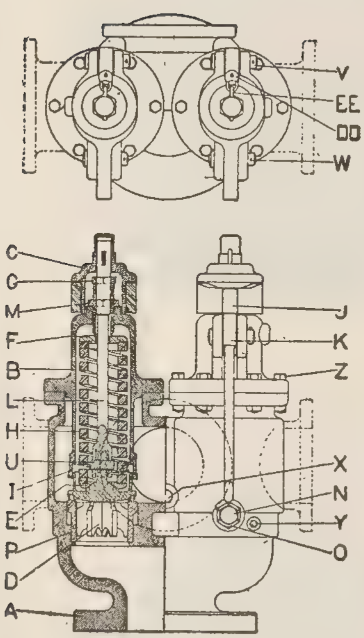

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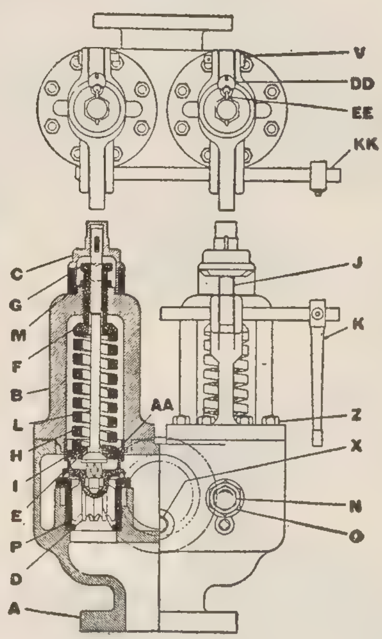

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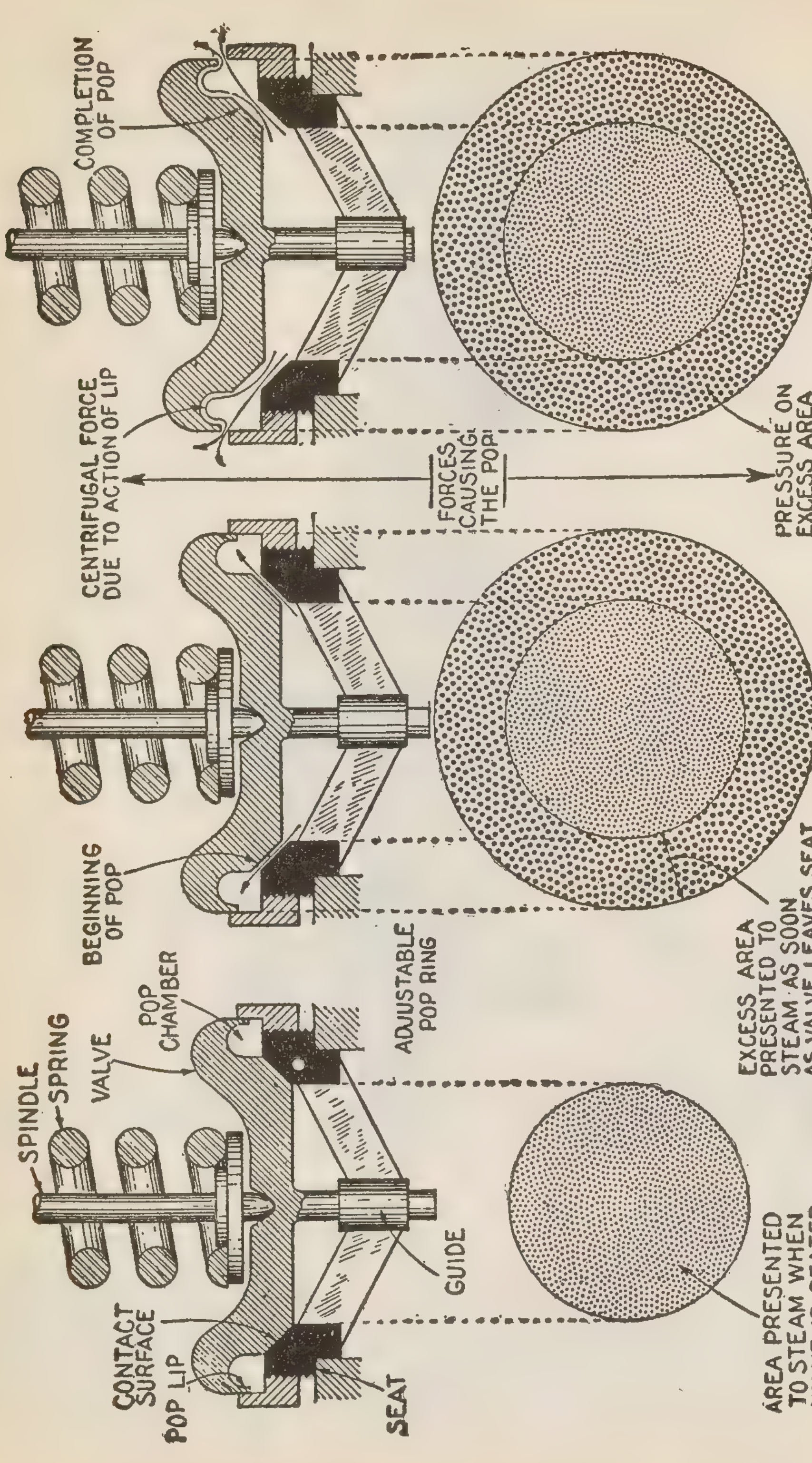
FIGS. 7,249 to 7,253.—Ashton marine pop safety valves. ***The parts are:*** A, shell; B, head; C, cap; D, wing valve; E, bottom disc; F, top disc; G, pressure screw; H, spring; I, head ring; J, fork; K, lever; L, spindle; M, pressure screw check nut; N, regulator; O, regular check nut; P, seat bushing; (nickel) P, seat bushing; (composition) R, upper spindle nut; S, lower spindle nut; T, studs; U, spindle pin; V, fork pin; W, lever pin; X, seat drip; Y, chamber drip; Z, body bolts and nuts; Z, stud nuts; AA, valve ring; CC, cap bolts; DD, lock and key; EE, lock pin.



FIGS. 7,254 to 7,256.—Construction and operation of a ***pop*** valve. Fig. 7,254 shows the essential parts with their names. ***In operation,*** as the valve begins to lift, steam rushes into the pop chamber and being confined (or partially so) therein acts on an excess area as indicated by the shaded ring, fig. 7,255, causing the valve to suddenly lift or "pop" to its full opening as in fig. 7,256, hence the name *pop* valve. The main object of the pop ring is to regulate the blow down or closing pressure. ***To regulate,*** if valve reduce pressure too much, lower pop ring, if not enough, raise pop ring.

The advantage of the pop valve is that it will blow very close to the set pressure, and also very stable in that it will not chatter but continue blowing until the pressure is appreciably reduced. The pressure at which the valve opens is called the blow off pressure, and the pressure at which it closes, the blow down pressure.

The construction and operation of the pop *feature* device is shown in figs. 7,254 to 7,256.

As shown in fig. 7,254 the valve is provided with a projecting *pop lip* and the seat with an adjustable *pop ring* forming the *pop chamber. In operation*, when the valve begins its opening movement, steam rushes into the pop chamber and suddenly acts on an excess area as in fig. 7,255, thus quickly accelerating the movement of the valve which opens wide with great rapidity as in fig. 7,256.

When the pop chamber opens to the atmosphere, there are two additional forces which tend to keep the valve open.

The pressure of the steam on the excess area presented by the pop chamber and the beveled passage way, and 2, the centrifugal force caused by the action of the curved pop lip in changing the direction of the steam.

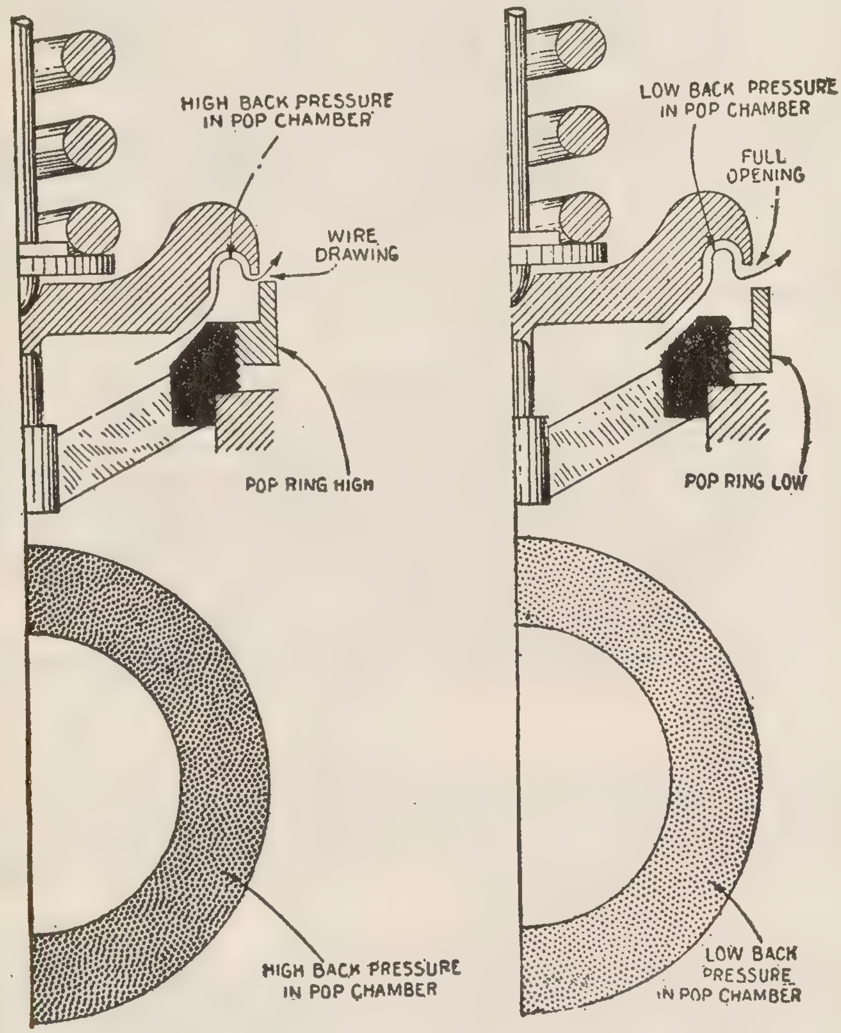
The intensity of the pop is regulated by adjusting the pop ring.

Evidently if the pop ring be screwed down so low that the pop chamber is open to the atmosphere when the valve is closed the valve will not open so suddenly as when it is adjusted to close the pop chamber when the valve is seated as in fig. 7,254.

NOTE.—***Installation and care of safety valves.*** All safety valves should be connected directly to the boiler with a close nipple or a short steam nozzle of the full valve size, or larger. In attaching the flange, the bolts should be drawn up evenly, as distortion of the valve seat may otherwise occur. In making a hydraulic test on a boiler the valve should be properly gagged, and not made to blow at a higher pressure by screwing down the spring. Safety valve springs are designed for a definite pressure, which is usually stamped on a tag fastened to the valve. If a valve is to be set at a pressure differing from the designed pressure by more than 5 or 10 pounds (depending upon the make of the valve) either above or below, a new spring should be furnished. Where safety valves are used with superheated steam, those of the outside spring type should be used in order to protect the metal of the spring from the high temperatures. ***In operation,*** all valves should be made to blow periodically to avoid the danger of sticking.

As usually constructed the pop ring fits loosely with the pop lip so that the pop chamber has a slight opening when ring is in high adjustment.

The main object of the ring is to regulate the blow down or closing pressure as explained in figs. 7,257 and 7,258.



FIGS. 7,257 and 7,258.—Pop valve with low and high adjustment of pop ring showing ***why*** the blow down or closing pressure is governed by the position of this ring. In fig. 7,257, the ring is in high adjustment so that with the valve fully opened as shown, the opening past the ring is restricted resulting in *wire drawing* of the steam with a higher back pressure in the pop chamber than in fig. 7,258, where the ring is in low adjustment giving free passage for the steam to the atmosphere. ***It must be evident*** that with the adjustment of fig. 7,257 giving *high* back pressure in the pop chamber, the valve will remain open longer and reduce the boiler pressure to a lower point than with the adjustment of fig. 7,258, giving *low* back pressure in the pop chamber.

Safety Valve Calculations.—The ridiculousness of the Government's refusal to grant an original license as engineer to anyone who "*is not able to determine the weight necessary to be placed on the lever of a safety valve (the diameter of valve, length of lever, distance from center of valve to fulcrum, weight of lever, and weight of valve and stem being known) to withstand any given pressure of steam in a boiler*," must be apparent to all who have given the matter any thought.

Especially is it ridiculous because of the method by which the applicant is required to make the calculation, viz.: by learning several so called rules parrot fashion, rather than by reasoning out the matter and writing an equation from which all calculations are readily obtained.*

The time spent in committing to memory meaningless rules, could be far better utilized in studying the principles of the problem and thus acquire some *real knowledge* rather than *artificial and dangerous knowledge.* From this view point it will be well to consider the principle of the safety valve upon which the calculations are based.

Principle of the Safety Valve.—When a boiler is in operation there are four forces acting on a lever safety valve, of which, one *tends to* **raise** *the valve off its seat* and the other three *tend to keep it* **closed**; when the first force slightly exceeds the sum of the other three forces, the valve will open and allow the steam to escape. The four forces just mentioned may be described as follows:

---

*NOTE.—***Unfortunately, some of the Government authorities,** presumably to facilitate the work of their examiners by having safety valve problems worked out in the same order, insist that the problems be worked according to the so called ***Roper's rules.*** It *should be distinctly understood* that Roper did not originate any "rules" but simply stated safety valve principles in the form of rules, indicating a certain *order* in which the various operations of multiplication, division, etc., are to be performed in solving the problems, just as he might say $3\times5=15$, while some other writer would express it $5\times3=15$, the result being the same in either case.

1. The force due to the steam *which tends to* **open** *the valve;*

It is equal to the area of the valve in square inches multiplied by the steam pressure as indicated by the steam gauge.

2. The force due to the weight of the valve and spindle, *which tends to* **close** *the valve;*

3. The force due to the weight of the lever, *which tends to* **close** *the valve;*

4. The force due to the weight of the ball, *which tends to* **close** *the valve.*

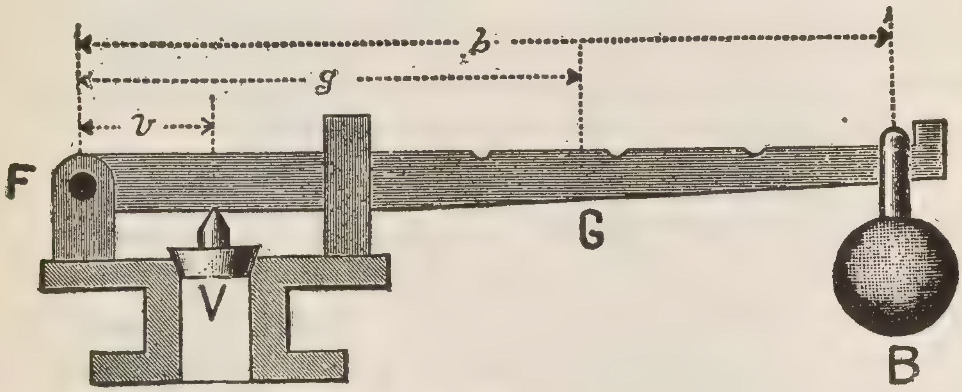


FIG. 7,259.—Lever safety valve with dimensions, etc., necessary in making calculations. *b*, Distance from fulcrum to ball; *g*, distance fulcrum to center of gravity of lever; *v*, distance fulcrum to spindle; F, fulcrum; V, weight of valve and spindle; G, weight of lever; B, weight of ball.

These forces act at different distances from a point called the *fulcrum*, which corresponds to the point F, in fig. 7,259 about which the lever turns. As indicated in the figure, the four forces are as follows:

NOTE.—***Comparison of lever and spring safety valves.*** The lever valve has no definite "pop" point, the valve lifting slowly in opening, and settling gradually in closing. A comparatively long range of blowing is necessary for the valve to effectively open, and a considerable excess pressure is necessary in specifications for such valves. ***Spring valves,*** have a positive opening to practically the full amount. ***At the popping point,*** a properly designed spring valve will lift its maximum, say .15 inch, and this lift will decrease approximately .01 inch per pound that the pressure in the boiler falls below the popping point. Other pressures may force the lift slightly higher with such a valve, but not sufficiently to make these pressures necessary to obtain the full valve efficiency. In specifying spring valves, therefore, an excess pressure should not be allowed, at least not over 1 or 2 pounds.

S = *total* pressure due to the steam tending to raise the valve;

This is equal to the steam pressure indicated by the steam gauge multiplied by the area of the valve. The area of the valve is equal to its diameter squared, multiplied by .7854.

The weights are measured in pounds, and the distances in inches.

The weight of the lever is considered as acting at its center of gravity *g*, distance from the fulcrum.

The center of gravity of the lever is that point where it would be in equilibrium if balanced over a knife edge or any other support with an edge, as in fig. 7,260.

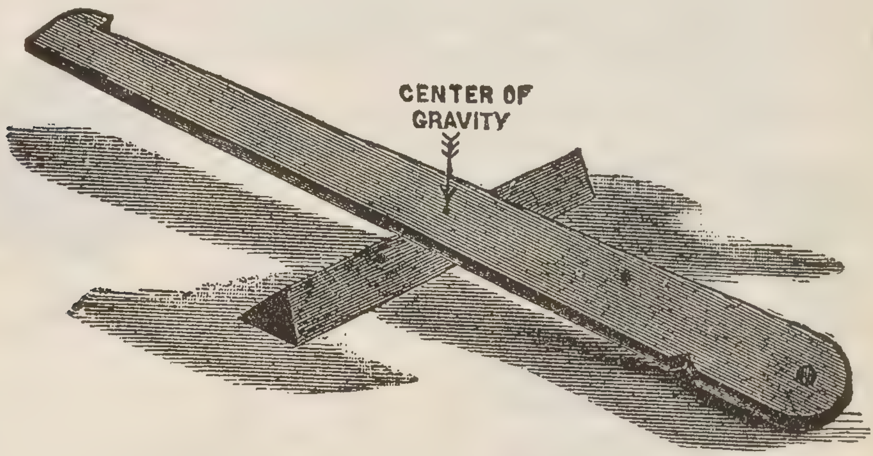


FIG. 7,260.—Method of finding the center of gravity of the lever. The center of gravity of the lever is the point where the bar would be in equilibrium if balanced over a knife edge or any other support with a sharp corner placed at right angles to the lever, as shown in the figure.

Now, since all of these forces do not act along the axis or central point of the valve (fig. 7,259), it is necessary to determine the *tendency of the several forces to produce rotation of the lever about the fulcrum F*.

In order to determine this, the *moments* of the several forces with respect to the fulcrum F, must be determined.

In mechanics the ***moment*** *of a force* is a *measure of its* ***effect*** *in producing* ***rotation*** *about a fixed point.*

The moment of a force, with respect to a point, is the product of the force multiplied by the perpendicular distance from the point to the direction of the force.

The fixed point corresponding to the fulcrum F, fig. 7,259 is called the *center of moments*, and the ***horizontal*** distance, *v*, *g*, or *b*, *the lever arm* or *leverage* of the force.

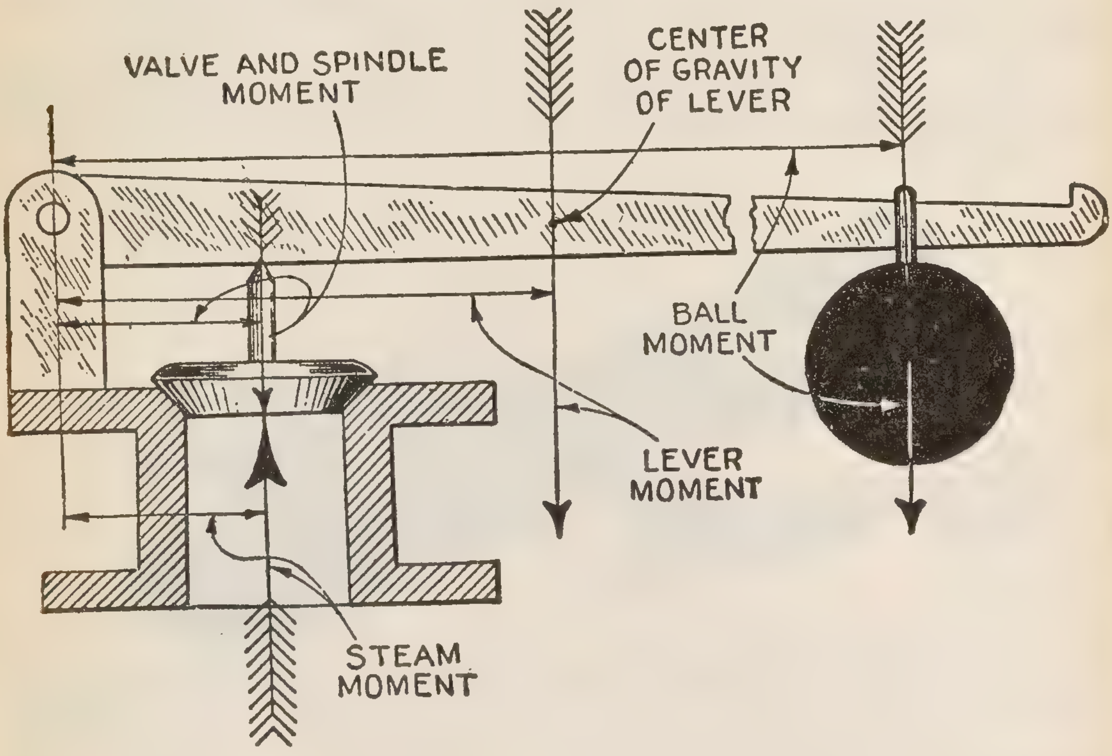


FIG. 7,261.—Diagram illustrating the four moments involved in safety valve calculations. One of these moments called the ***steam moment** which tends to **open** the valve;* this is resisted by the other three moments called the ***valve and spindle moment,*** the ***lever moment,*** and the ***ball moment** which tend* to ***close** the valve*. Evidently when the valve is at the ***point** of blowing off*, the ***steam** moment* = ***valve and spindle** moment* + ***lever** moment* + ***ball** moment*. When this condition obtains and the steam pressure increase a very small amount sufficient to cause the steam moment to overcome the ***friction** of the mechanism*, the valve will open and blow off.

The moment of the ball B, in fig. 7,259 with respect to the fulcrum F, for instance, is equal to the weight of the ball multiplied by its distance from F, that is, moment of the ball = B×*b* or simply B*b*.

The four moments to be considered in solving the safety valve problem are as follows:

1. Moment due to the ***steam;***

It is equal to the *total* pressure of the steam acting on the valve multiplied by the distance from fulcrum to center of valve; that is, in fig. 7,259 ***steam moment*** $= Sv$.

2. Moment due to the *weight* of the ***valve and spindle;***

It is equal to the weight of the valve and spindle multiplied by the distance from fulcrum to center of valve; that is, ***valve and spindle moment*** $= Vv$.

3. Moment due to the weight of the ***lever;***

It is equal to the weight of the lever multiplied by the distance from the fulcrum to the center of gravity of the lever; that is, ***lever moment*** $= Gg$.

4. Moment due to the weight of the ***ball.***

It is equal to the weight of the ball multiplied by the distance from the fulcrum to the ball; that is, ***ball moment*** $= Bb$.

Now, when the valve is at the ***point*** *of blowing off*, the first moment *which tends to* ***raise*** *the valve* will equal the sum of the other three moments *which tend to keep the valve* ***closed*** that is:

$$\left\{\begin{matrix}\textit{steam}\\ \textit{moment}\\ S\times v\end{matrix}\right\} = \left\{\begin{matrix}\textit{valve and}\\ \textit{spindle moment}\\ V\times v\end{matrix}\right\} + \left\{\begin{matrix}\textit{lever}\\ \textit{moment}\\ G\times g\end{matrix}\right\} + \left\{\begin{matrix}\textit{ball}\\ \textit{moment}\\ B\times b\end{matrix}\right\}$$

or simply:

$$\mathbf{Sv = Vv + Gg + Bb.}$$

This is the safety valve equation with which any problem is easily solved. In working out an example, the given values are substituted for the letters and the equation solved for the unknown letter.

Example:—What weight ball must be put on a 3″ safety valve so that it will blow at 100 lbs., if the weight of valve and spindle be 8 lbs., lever 24 lbs., distance of valve from fulcrum 4″; distance of center of gravity from fulcrum 16″; distance from fulcrum to ball 38″?

S, the total pressure tending to raise the valve is equal to the steam pressure multiplied by the area of the valve in square inches $= 100 \times \text{diam.} \times \text{diam.}^2 \times .7854 = 100 \times 3 \times 3 \times .7854 = 706.9$ lbs., say 707 lbs.

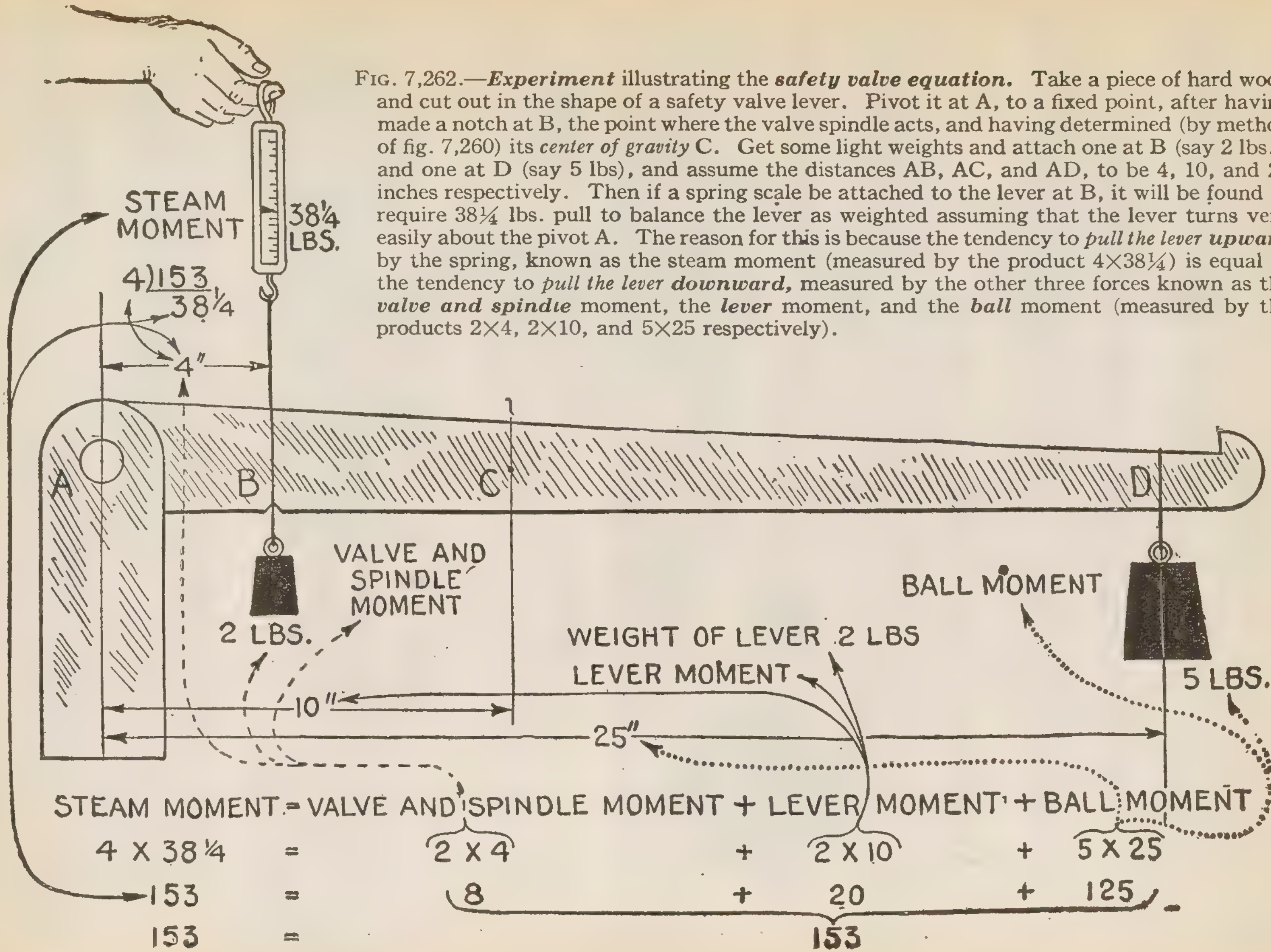


Fig. 7,262.—***Experiment*** illustrating the ***safety valve equation.*** Take a piece of hard wood and cut out in the shape of a safety valve lever. Pivot it at A, to a fixed point, after having made a notch at B, the point where the valve spindle acts, and having determined (by method of fig. 7,260) its *center of gravity* C. Get some light weights and attach one at B (say 2 lbs.), and one at D (say 5 lbs), and assume the distances AB, AC, and AD, to be 4, 10, and 25 inches respectively. Then if a spring scale be attached to the lever at B, it will be found to require 38¼ lbs. pull to balance the lever as weighted assuming that the lever turns very easily about the pivot A. The reason for this is because the tendency to *pull the lever* ***upward*** by the spring, known as the steam moment (measured by the product 4×38¼) is equal to the tendency to *pull the lever* ***downward,*** measured by the other three forces known as the ***valve and spindle*** moment, the ***lever*** moment, and the ***ball*** moment (measured by the products 2×4, 2×10, and 5×25 respectively).

Now write out the equation and substitute the values given in the example and value just found for S, under the proper letters, thus:

$$\underbrace{Sv}_{707\times4} = \underbrace{Vv}_{8\times4} + \underbrace{Gg}_{24\times16} + \underbrace{Bb}_{B\times38}$$

multiplying

$$2{,}828 = 32 + 384 + 38B$$

and adding

$$2{,}828 = 416 + 38B$$

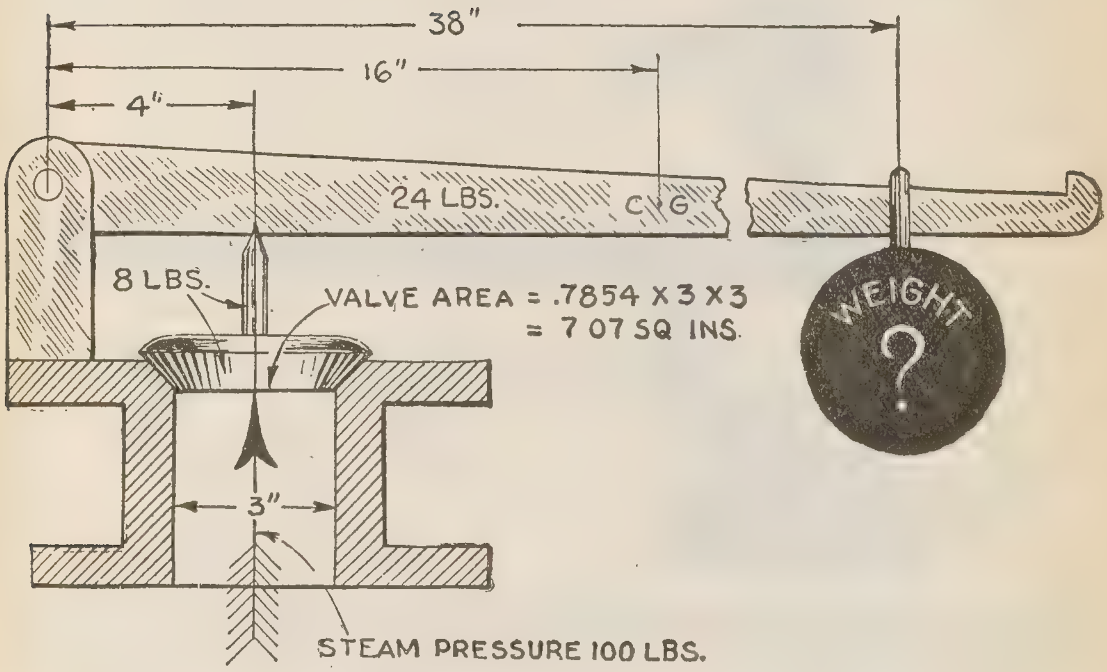


FIG. 7,263.—***Example: To find what weight*** must be put on the safety valve when the conditions are as indicated in the figure.

The equation must be "solved for B," which means that everything must be transferred to the left hand side of the equality sign except the B. The first step then is to get the 416 on the left hand side; to do this, subtract 416 from both sides, thus:

$$\begin{array}{r@{}l}
2{,}828 = & 416 + 38B \\
416 & 416 \\
\hline
2{,}412 = & 38B
\end{array}$$

As it now stands, 2,412 = 38B, or in other words, 38B = 2,412:

Now, divide both sides by 38, thus:

$$\frac{38B}{38}=\frac{2,412}{38}, \text{ hence:}$$

$$B=\frac{2,412}{38}=63.4 \text{ lbs., weight of ball.}$$

When the engineer has to solve a safety valve problem in actual practice, he may do so without finding the center of

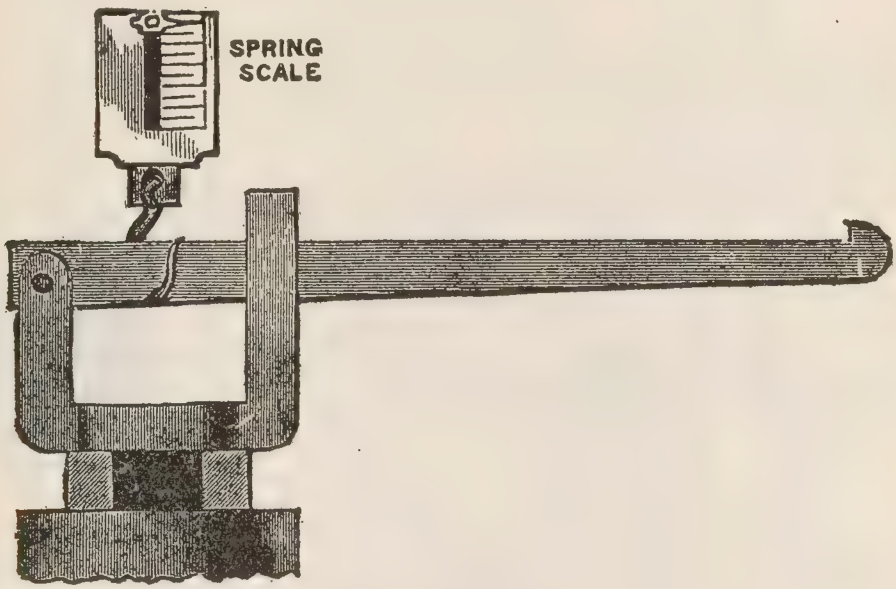


FIG. 7,264.—Weighing the force exerted by the lever; by thus obtaining the downward thrust due to the lever, the calculation is simplified as explained on page 2,682.

gravity of the lever, if he use a spring balance as in fig. 7,264.

The balance should be hooked under the point at which the valve spindle acts and then by pulling up on the balance, the actual downward pressure of the lever *at this point* can be determined. To this weight should be added the weight of the valve and spindle.

The force then will be in as fig. 7,265 from which the equation is:

$$S v = M v + B b$$

here M, is equal to the sum of the pressure of the lever as indicated on the scale and spring fig. 7,264 plus the weight of the valve and spindle; the other letters are as before.

If the weight of the ball, or its distance from the fulcrum be required, the equation can be still further simplified by letting M, in fig. 7,265, represent the *sum* of the pressure of the lever as indicated on the spring scale plus the weight of the valve and spindle, subtracted from the *total* pressure of the steam on the valve. The equation then becomes

$$M v = B b$$

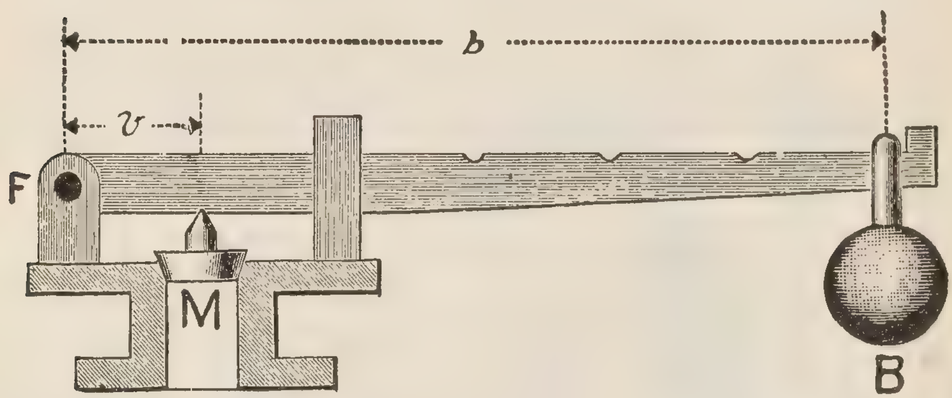
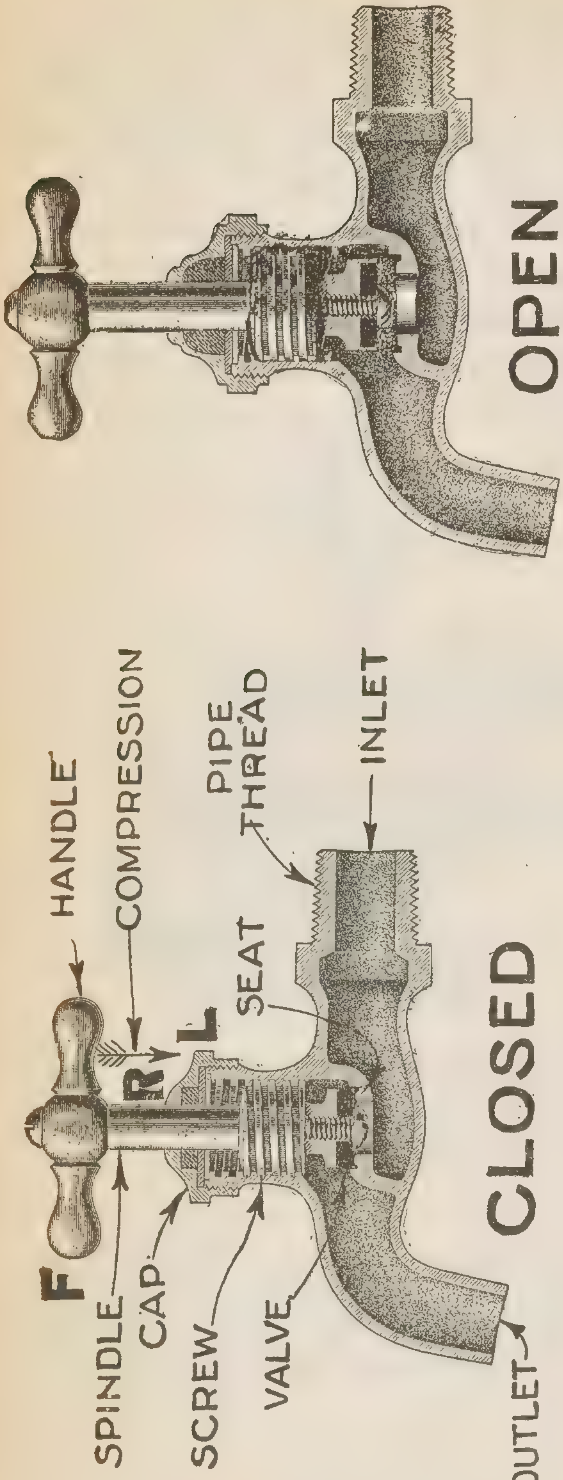


FIG. 7,265.—Lever safety valve with dimensions, etc., necessary in making calculations where the thrust due to the lever is determined by a spring balance as in fig. 7,264. *b*, distance fulcrum to ball; *v*, distance fulcrum to valve, M = S − L, that is, the total pressure due to the steam tending to raise the valve, less the downward thrust due to the lever as measured in fig. 7,264; F, fulcrum; B, weight of ball.

Faucet.—The terms *faucet* and *bibb*, are used indiscriminately to signify *a faucet fitted with a valve controlling the* **outlet** *of a pipe conveying a liquid*. With respect to the mode of operation faucets are classed as

1. Compression.



FIGS. 7,266 and 7,267.—Compression faucet. Fig. 7,266, closed position; fig. 7,267, open position.

a. Plain.
b. Self closing.

2. Fuller.
3. Ground key.

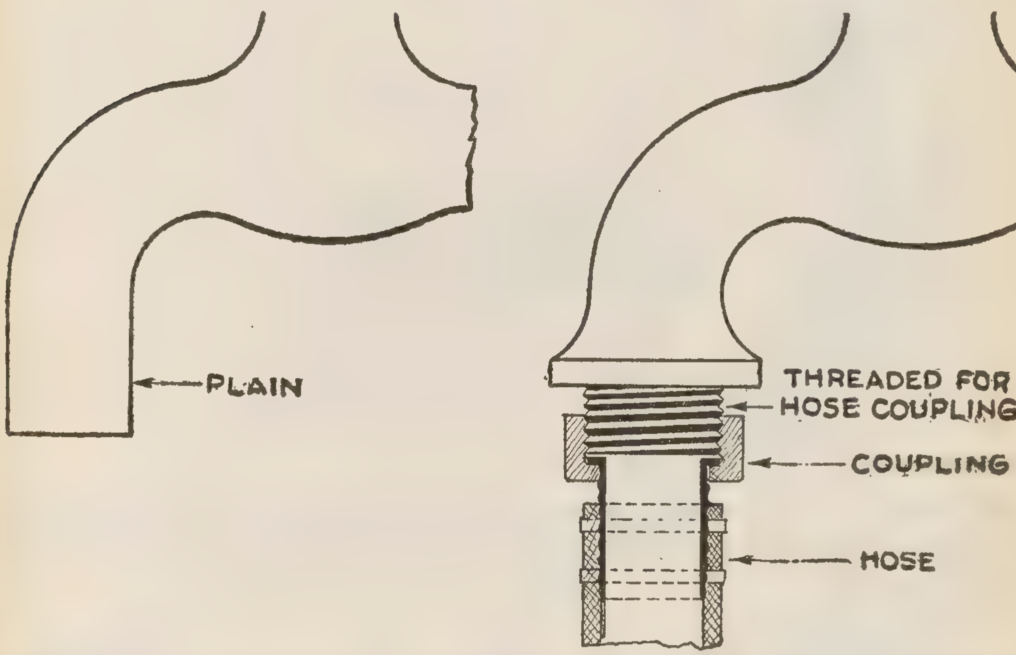
A compression faucet is a form of faucet in which *the flow of water is shut off by compressing a washer valve against a seat by turning a screw spindle,* the threaded portion of the spindle working in a corresponding thread in the body of the faucet as shown in closed and open positions in figs. 7,266 and 7,267.

The outlet end of all types of faucet is made either plain as in fig. 7,268 or threaded so that a garden hose may be attached as in fig. 7,269.

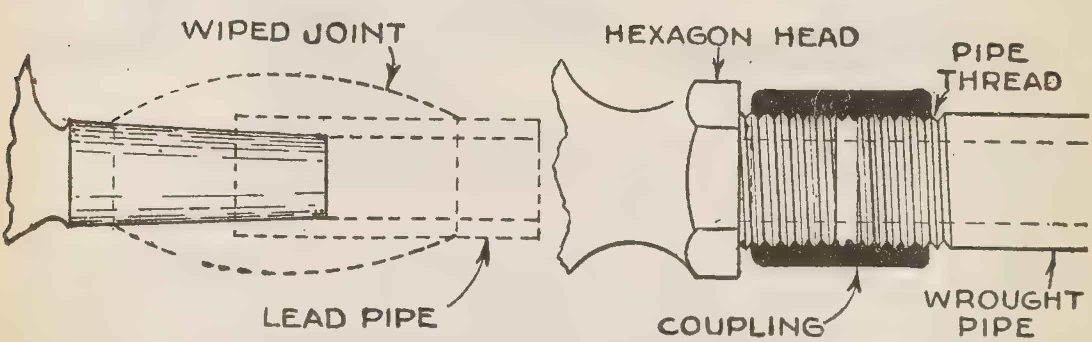
The inlet ends are made in numerous forms; for wiped or threaded joints as in figs. 7,270 and 7,271 and for supports of various kinds as shown in figs. 7272 and 7273.

Compression faucets, although the movement in closing is against the pressure of the liquid, are suitable for moderate and heavy pressures, such as is common on city mains.

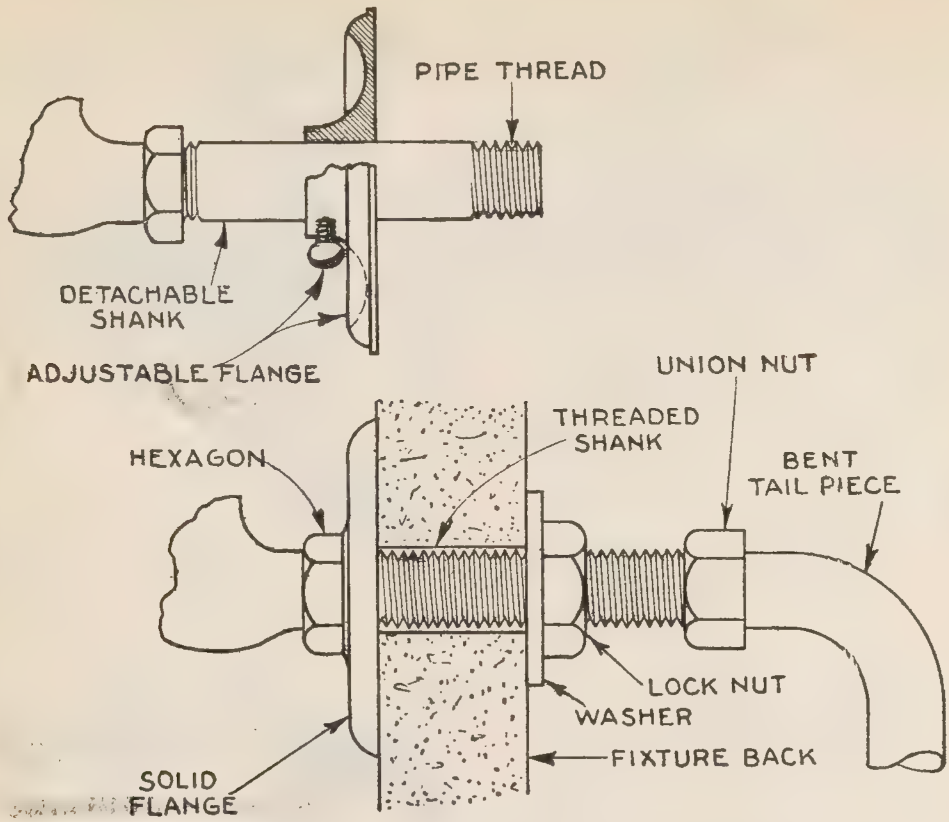
Being fitted with a removable washer valve they are adapted to water containing impurities as the washer is easily removed. When washer becomes worn or cut causing faucet to leak, shut off water from the line, then unscrew cap L, (fig. 7,266) and spindle R, by turning handle F, counter clockwise. Hold spindle in the left hand as in fig. 7,278, remove retaining



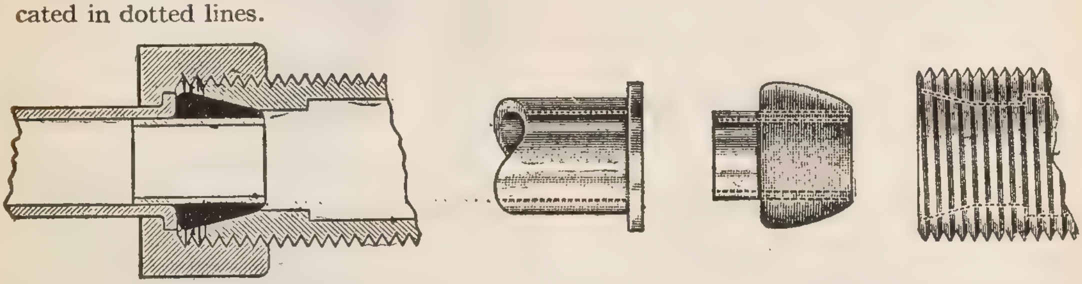
FIGS. 7,268 and 7,269.—Outlet end of faucet. Fig. 7,268, plain; fig. 7,269, threaded for hose coupling.



FIGS. 7,270 and 7,271.—Inlet end of faucet. Fig. 7,270, tapered shank for wiped joint; fig. 7,271, threaded shank for wrought pipe; note the hexagon head for turning faucet in screwing it into the coupling or other pipe fitting.



FIGS. 7,272 and 7,273.—Inlet end connection of faucet. Fig. 7,272, detachable shank with adjustable flange; fig. 7,273, solid flange, threaded shank with lock nut and bent tail piece (see figs. 7,274 to 7,277); the solid flange may be without, or with hexagon head as indicated in dotted lines.



FIGS. 7,274 to 7,277.—Mueller "fitsall" supply pipe connection. The supply pipe is made of annealed seamless tubing and the elbow is flanged to form the bearing or the coupling nut. The cones which form the joint to the openings in the cock are made of lead and fitted over a brass ferrule which is pressed in the elbow against the flange. By tightening the coupling nuts, the lead cones conform to the size and taper of the cock openings, therefore they will fit cocks of any style, or manufacture. In using basin or bath cocks of other manufacture with these supply pipes, the coupling nut furnished with the cock must be used. Coupling nuts of Mueller basin and bath cocks will not fit cocks of every manufacture, as no standard size or thread is used on cocks of the different makes. The lead cone connection and lead slip joint gasket are not affected by hot water and will not deteriorate as rubber does. These pipes can be disconnected and connected again any number of times without affecting the lead cones.

screw, and either reverse washer or replace with a new one, securing it in position with the retaining screw. The spindle is now replaced in the faucet body and water turned on in the main.

In localities where water rates are high a saving can be effected by installing self-closing compression faucets, one type of which is shown in fig. 7,280.

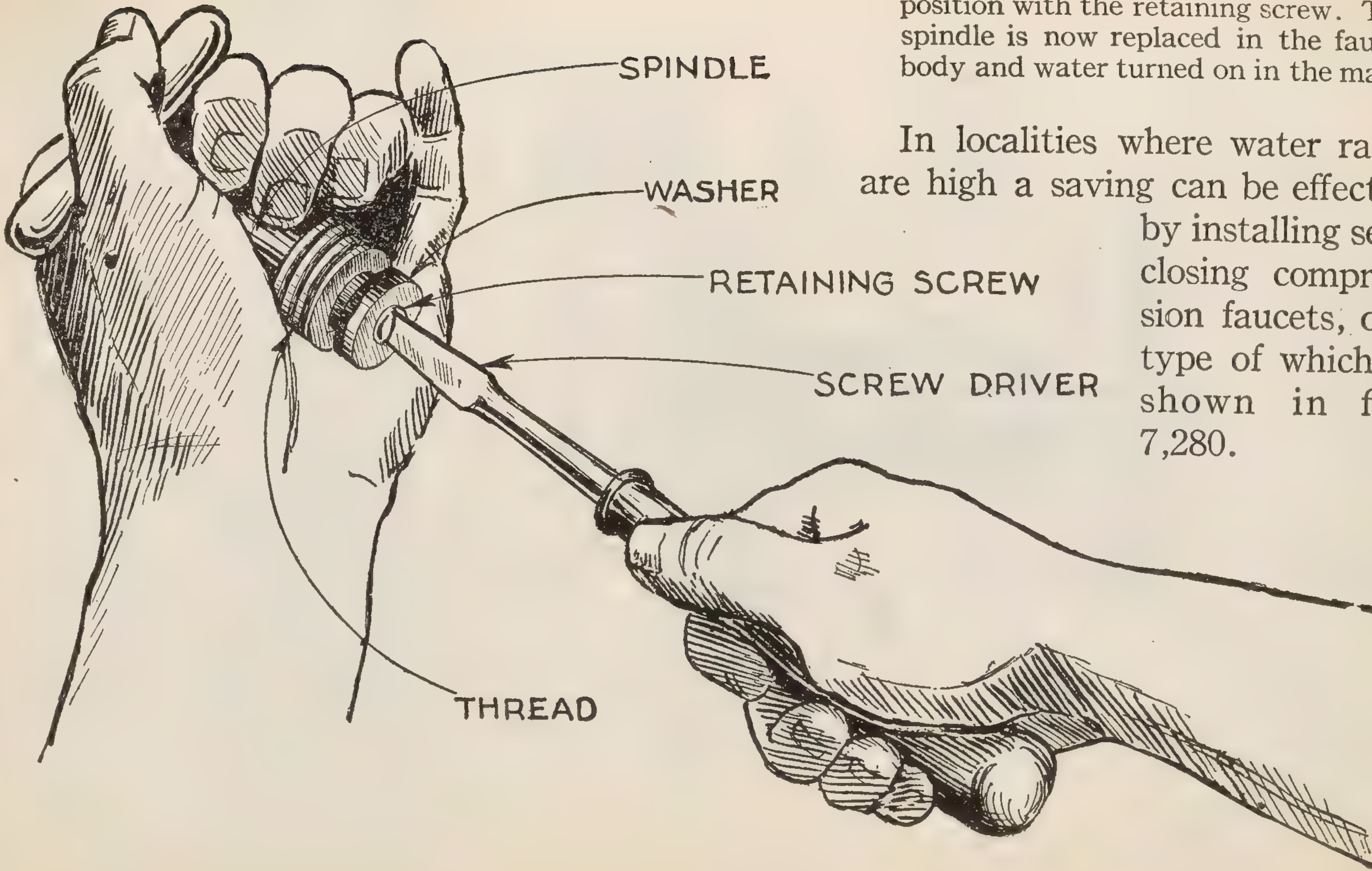


FIG. 7,278.—Method of removing washer valve from a compression faucet.

This insures the economical use of water because it automatically closes as soon as released by the action of spring and coarse thread on spindle which works in a similar thread cut in the neck of the faucet.

Another form of self-closing compression faucet is shown in fig. 7,280.

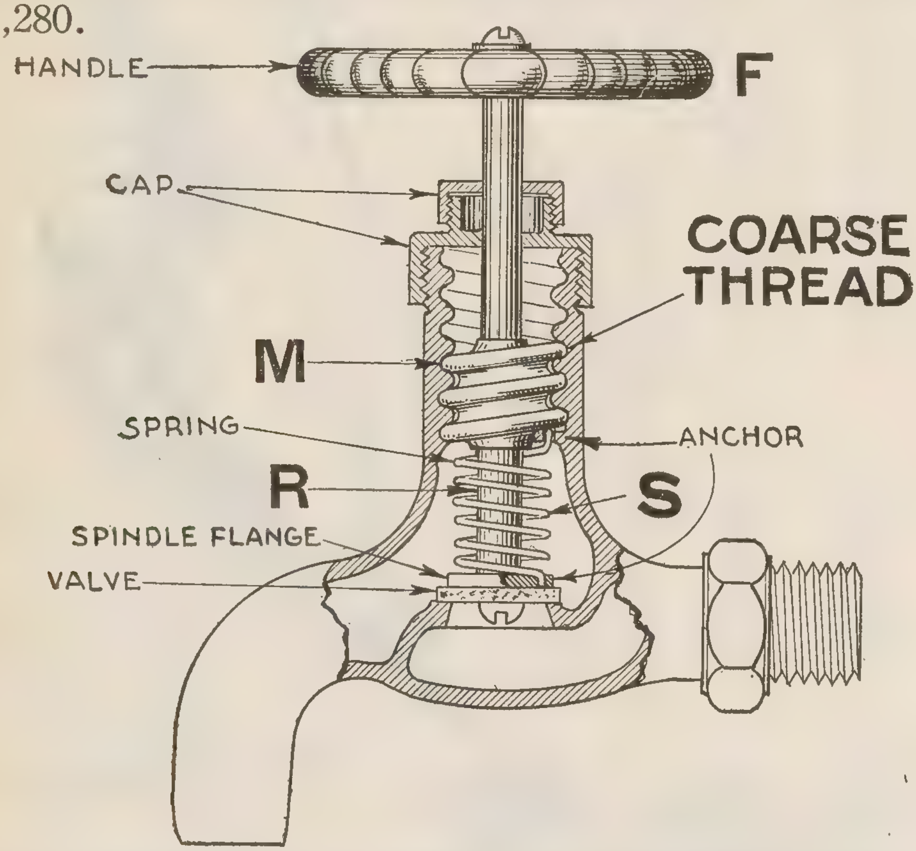


FIG. 7,279.—Self-closing compression faucet, coarse thread twisted spring type. ***In operation,*** when the spindle R, is turned counter-clockwise by means of the handle F, the coarse thread M, working in the threaded portion of the body lifts the spindle, thus opening the valve. This counter-clockwise turning of the spindle R, both compresses, and coils up the spring S, since it is anchored or fastened to the spindle flange at its lower end, and to the body of the faucet at its upper end. When the handle is released the spring uncoils, causing the spindle to turn clockwise and close the valve, in which position it is held against the pressure of the water by the compression of the spring.

Self-closing faucets while economical in the use of water are objectionable in that the tendency is for the fixtures to receive too little water to keep them in proper sanitary condition.

The fuller type of faucet is a very desirable type for use on low pressure lines, such as in dwellings with tank supply or

city main with reducing valve, because it is quick opening and the valve is easily renewed. Since *it closes with the pressure*, it is liable to cause water hammer especially on long lines unless provided with an air chamber.

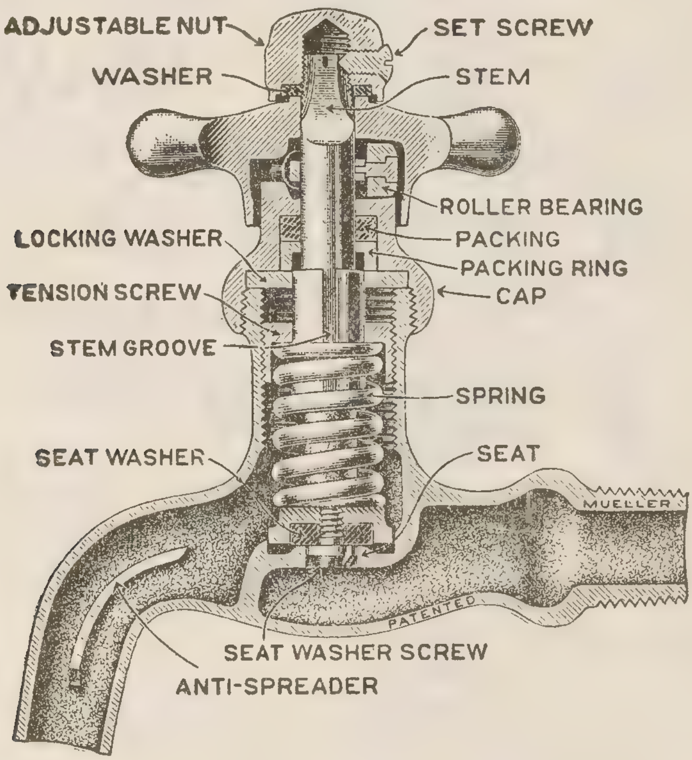
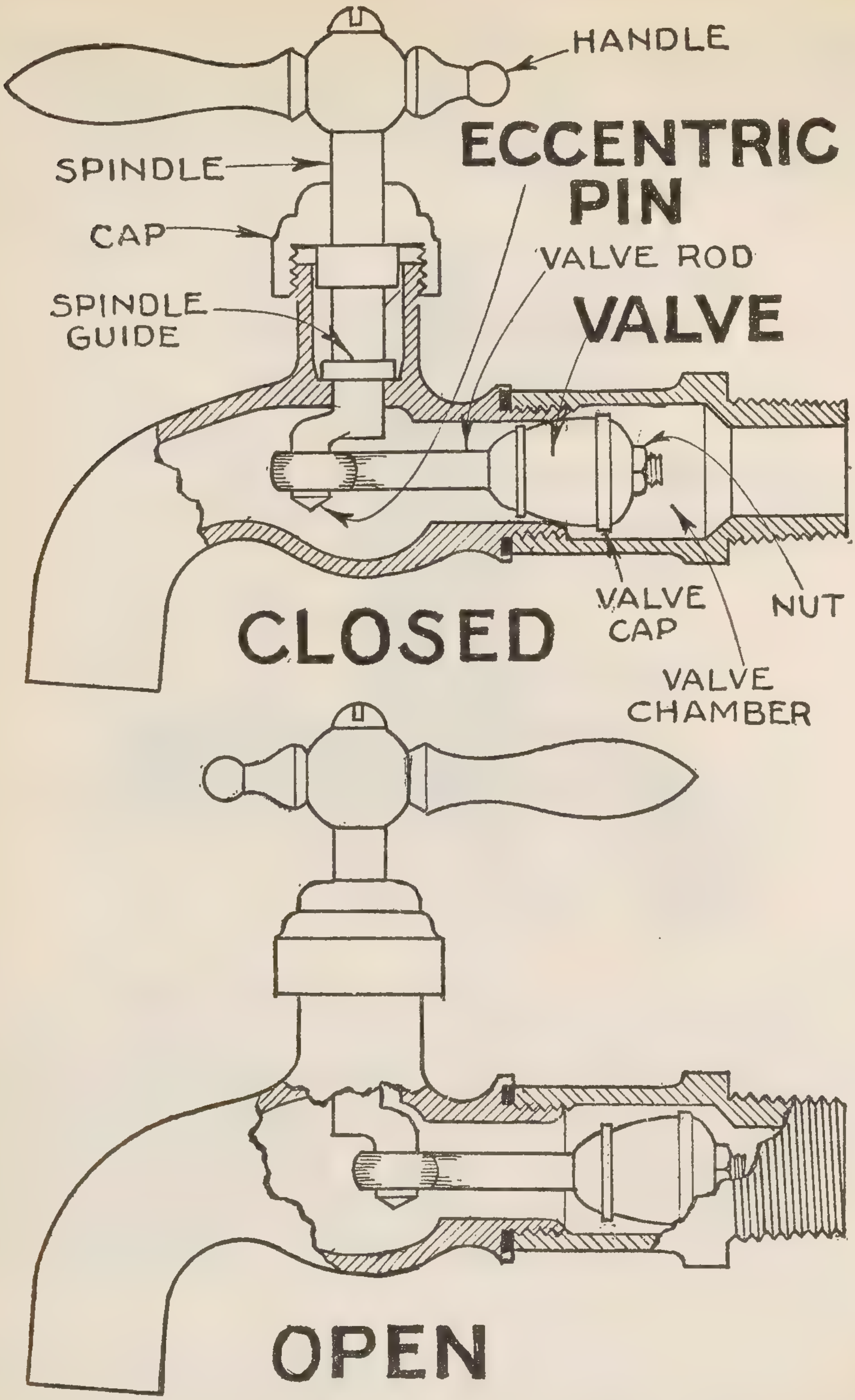


FIG. 7,280.—Self-closing compression faucet. This type is constructed to close against the pressure by spring tension. The spring is made of red phosphor-bronze and can be adjusted by the tension screw to operate against any pressure. ***In operation,*** a set of three rollers travels on two right and left spiral tracks, one of which is in a recess in the handle and the other on the top of the bonnet, or cap. The rollers revolve upon axles which are equidistant arms of a spider, or yoke, around the stem. All the rollers are bound to travel the same distance, share alike in the work and maintain the same position relative to each other. This roller bearing feature is intended to reduce friction to a minimum and make the opening and closing easy. About a quarter turn of the handle, either to the right or left, gives a full opening. The hexagonal nut above the handle screws onto the stem and receives the force of the spring tension when the handle is turned in opening. The nut also can be adjusted so as to compensate for wear. The packings are composed of cloth insertion rubber saturated with lubricant.

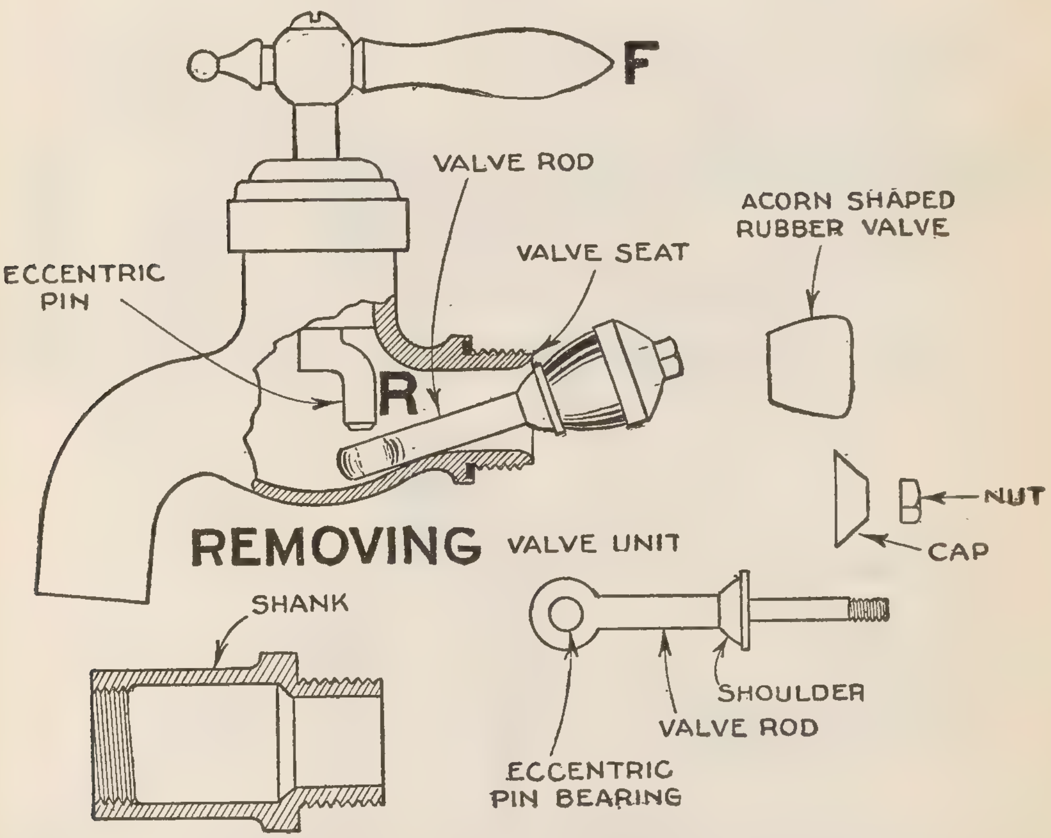
Figs. 7,281 and 7,282 show the valve in closed and open positions and evidently because of its principle of operation it is not adapted to high pressure service.



FIGS. 7,281 and 7,282.—Fuller faucet. Fig. 7,281, closed position; fig. 7,282, open position.

As shown in the illustration the Fuller faucet *is provided with an acorn shaped rubber valve which is drawn to the seat to shut off the water by a small rod eccentrically connected to a lever handle.*

The method of removing the valve unit in case of a worn valve rod is shown in figs. 7,283 to 7,288, the parts being shown also dissembled to clearly illustrate the construction.

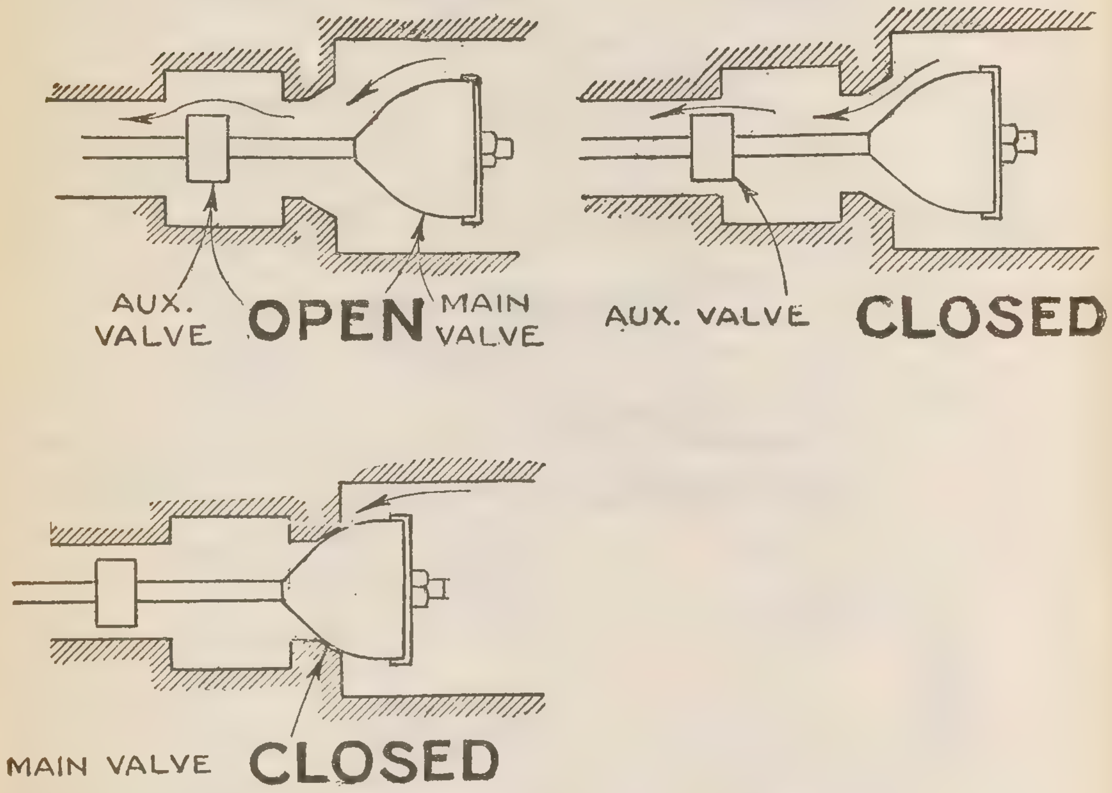


FIGS. 7,283 to 7,288.—Dissembling of Fuller faucet illustrating the removal of valve unit for valve rod renewal. ***To disassemble,*** unscrew the shank and turn handle to full open position, F, bringing eccentric pin to position R, when the valve unit is easily removed by tilting it as shown. ***In some patterns*** the cap must be unscrewed and the valve spindle lifted. In the disassembly the construction of the valve unit is very plainly shown, the valve having a hole through it, through which the rod is threaded in assembling. If the valves do not seat tight enough adjust by screwing up the nut on the end of the valve rod which will compress the rubber enlarging the end which bears on the seat.

Some Fuller cocks are provided with a device to prevent water hammer in closing the valve. It consists of a form of auxiliary valve which partially closes the water passage before the main valve seats. The working of this arrangement is shown *in principle* in figs. 7,289 to 7,291.

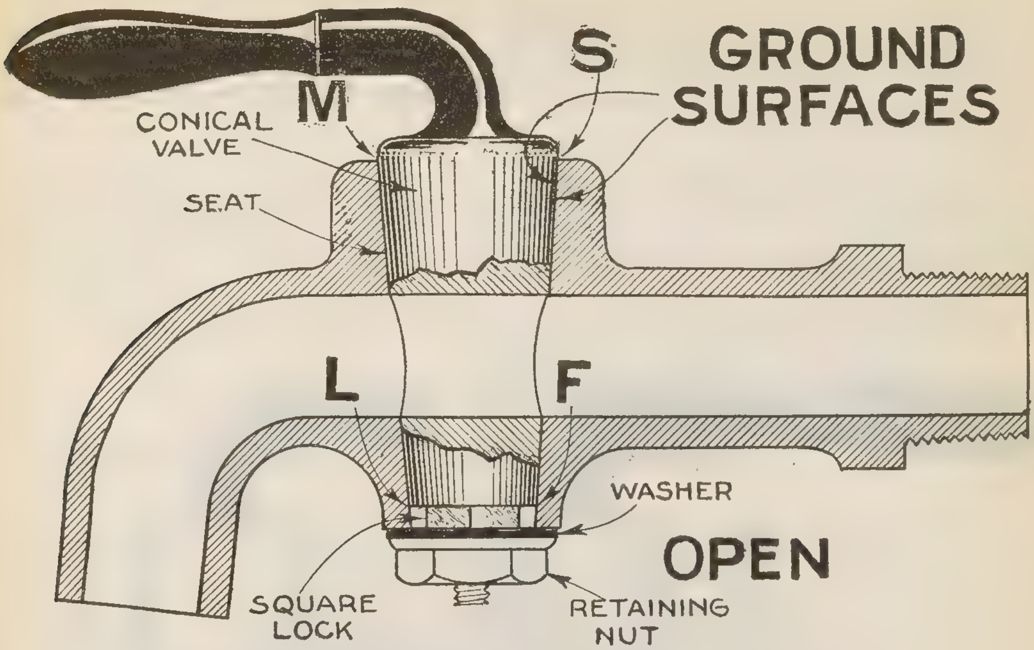
A ground key faucet is one having *a valve in the form of a conical plug which fits and works in a conical seat forming part of the faucet body.*

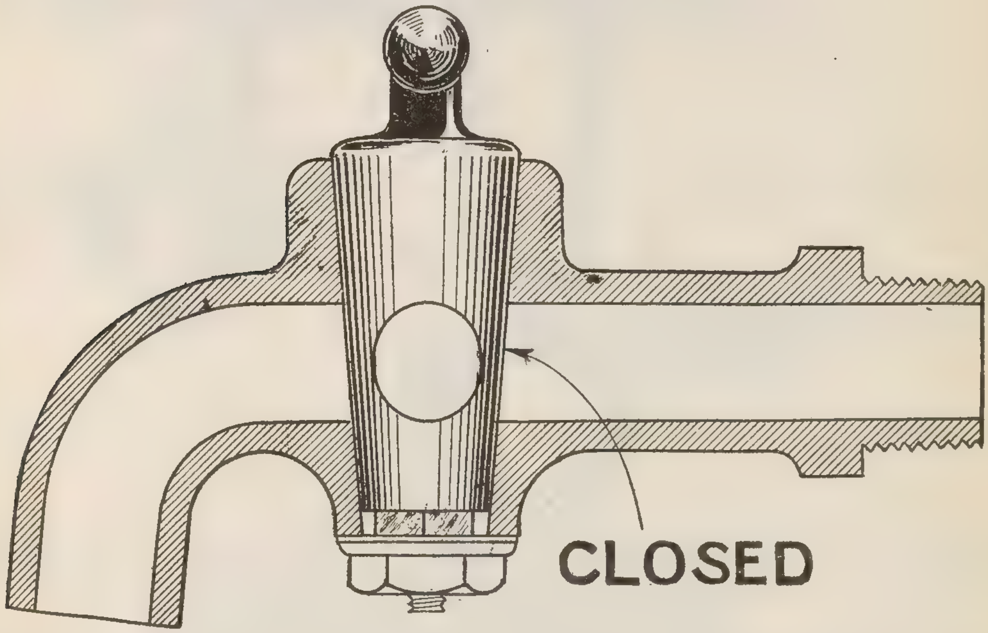
The plug or valve is carefully ground into the seat so that a tight joint is obtained. The construction and operation of this type faucet is shown



FIGS. 7,289 to 7,291.—Method of preventing water hammer in Fuller faucet. An auxiliary or preliminary valve in front of the main valve is arranged to partially close the water passage, thus throttling the flow of water *before* the main valve closes. Fig. 7,289, valves fully opened; fig. 7,290, auxiliary valve closed; fig. 7,291, main valve closed. By the gradual closing thus obtained the flow of the water is gradually brought to rest instead of stopped suddenly.

in figs. 7,292 and 7,293. Owing to the conical shape of the valve its diameter at the upper end is larger than at the lower end accordingly there is a tendency for the pressure of the water to lift the valve off its seat and hence the necessity of the nut at the lower end.



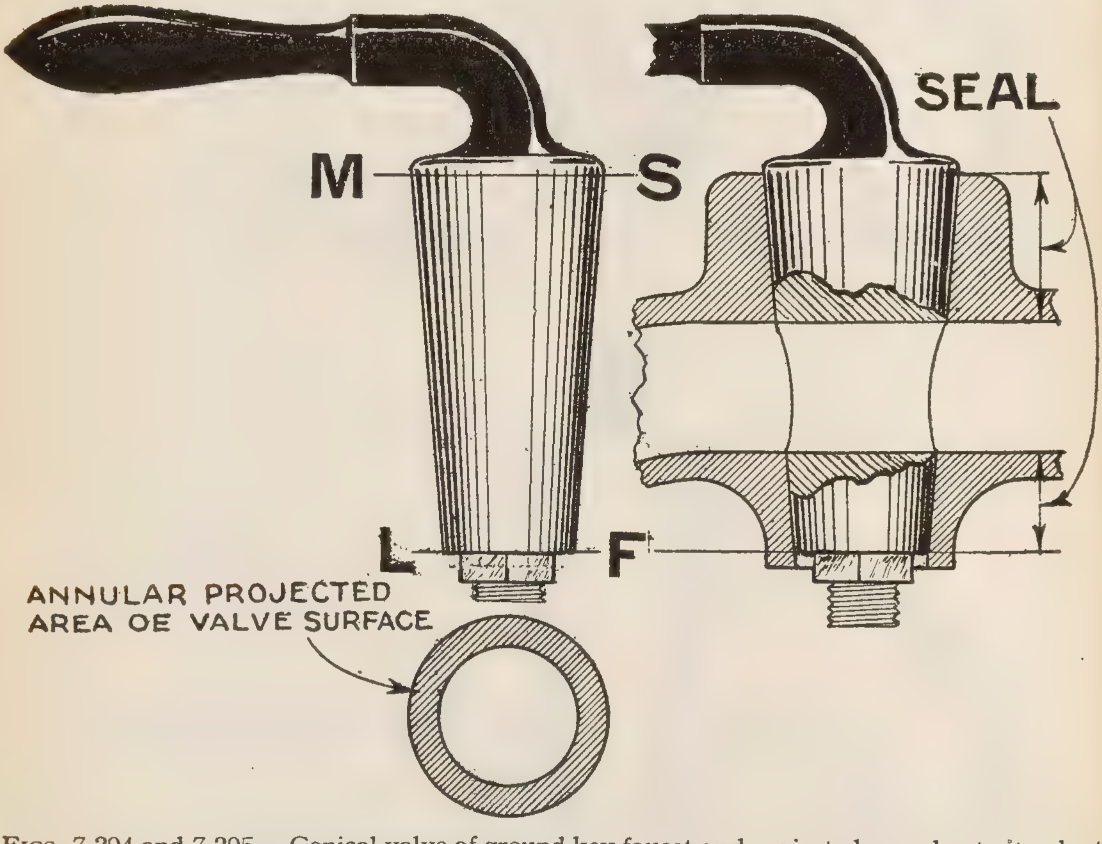


FIGS. 7,292 and 7,293.—Ground key faucet. Fig. 7,292, open position; fig. 7,293, closed position. ***In construction,*** a conical plug valve having a passageway cut through it fits a corresponding conical seat in the faucet body. The valve is prevented being lifted from its seat by a retaining nut which bears against the washer. The latter fits over a square projection of the valve so that it will turn with the valve otherwise the nut would come unscrewed due to the turning of the valve. ***In operation,*** when the valve is in the position shown, the passageway is in line with the passage through the body of the faucet, permitting flow. Turning the handle 90° either to right or left, will close the valve as in fig. 7,293.

To illustrate, suppose the sectional area of the valve at LF, to be 1 sq. in. and at MS, 1¼ sq. ins., water pressure 60 lbs. Then difference of areas = 1.25 − 1 = .25 sq. ins. and lifting force = .25×60 = 15 lbs. as illustrated in fig. 7,294.

An inherent defect of ground key faucets is the tendency to leak.

If the water be sandy or gritty, the sand will work in between the valve



FIGS. 7,294 and 7,295.—Conical valve of ground key faucet and projected area due to its slant surface, being the effective area acted upon by the water pressure, tending to lift the valve from its seat.

and the seat and cut minute passageways along the contact surfaces producing leaks. Accordingly ground key faucets should never be used with impure water and to guard against cutting and warping extra heavy faucets should be used rather than standard weight, because the *seal* (see fig. 7,295) is greater, and the body of the faucet is thicker and consequently stronger to resist lateral pressure in opening and closing. It is this lateral

pressure that tend to distort or warp the surface of the seat. This may be avoided by employing the correct method of opening and closing the valve, especially if the valve stick, making it necessary to use considerable pressure in turning the valve is shown in fig. 7,301.

Cocks.—A cock is a type of valve *intended to form a convenient means of shutting off the flow of water in a* ***line*** *of piping.* It is similar in construction to a ground key faucet but differs

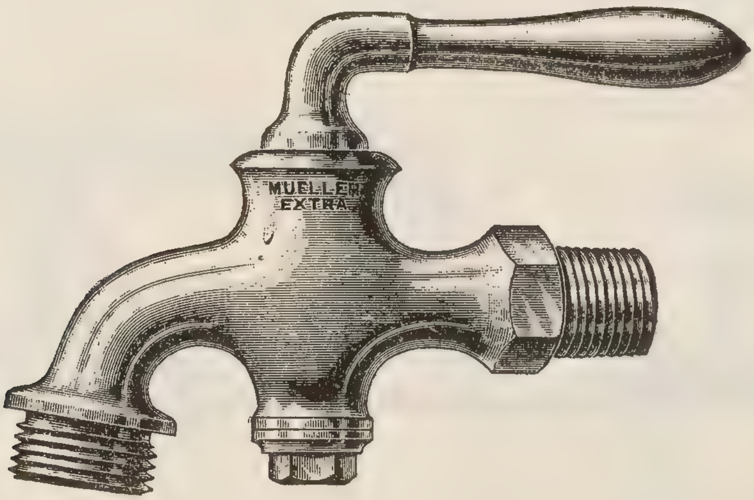


Fig. 7,296.—Mueller extra heavy ground key faucet, threaded inlet connection and outlet threaded for hose connection.

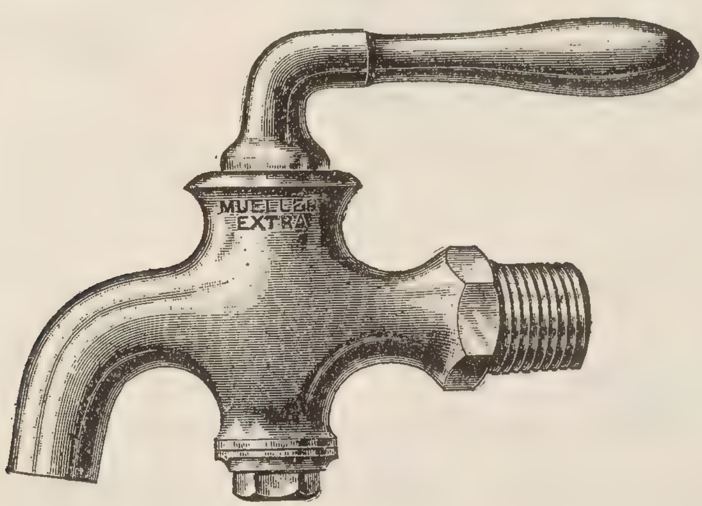


Fig. 7,297.—Mueller extra heavy ground key faucet, threaded inlet connection, plain outlet.

in that it is arranged to be placed *in the pipe line* instead of *at an outlet*. The distinction is shown in fig. 7,298.

To meet the various requirements of service there are several kinds of cocks as follows:

1. Straight way.
2. Three way.
   a. Two port.
   b. Three port.

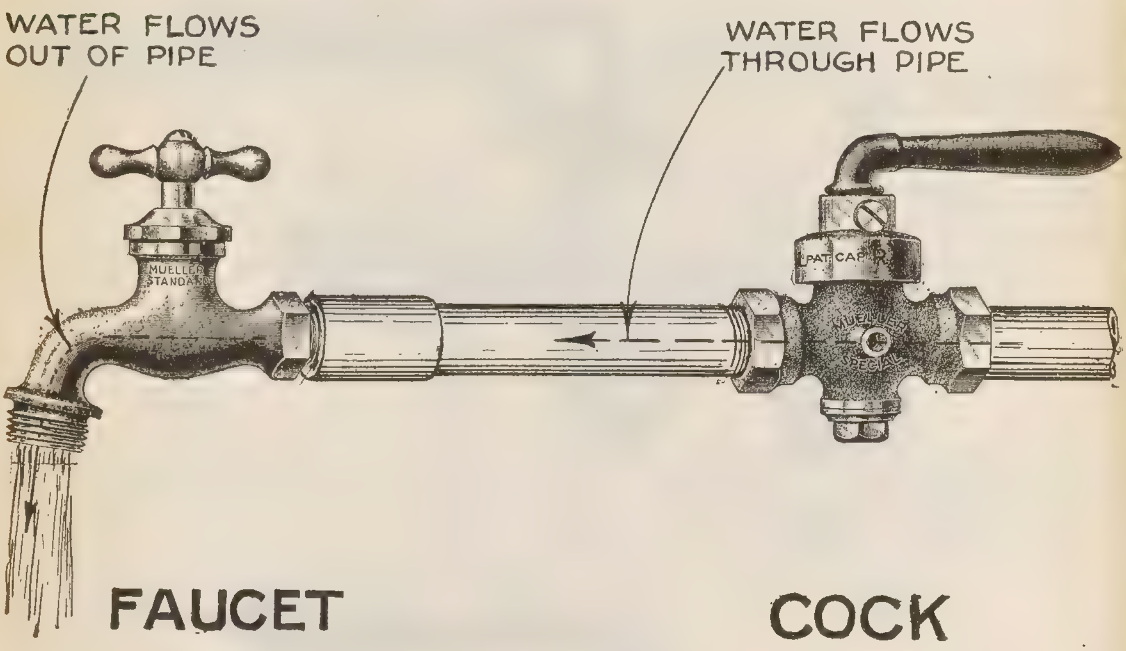


FIG. 7,298.—Distinction between a faucet and a cock.

3. Four way.
   a. Two port.
   b. Three port.
   c. Four port.
4. Swing.
5. Waste or drain.
6. Corporation.

Fig. 7,299 show the construction of a straight way cock being virtually the same as a ground key faucet (compare with

figs. 7,292 and 7,293) except the inlet and outlet ends and the detachable handle.

The general appearance of some patterns of straight way cocks (for steam) is shown in figs. 7,303 to 7,308. It will be seen that there is a great variety of patterns to meet all requirements.

It should be distinctly understood that the primary duty of a cock is to *control* rather than *regulate* the flow of water, that is,

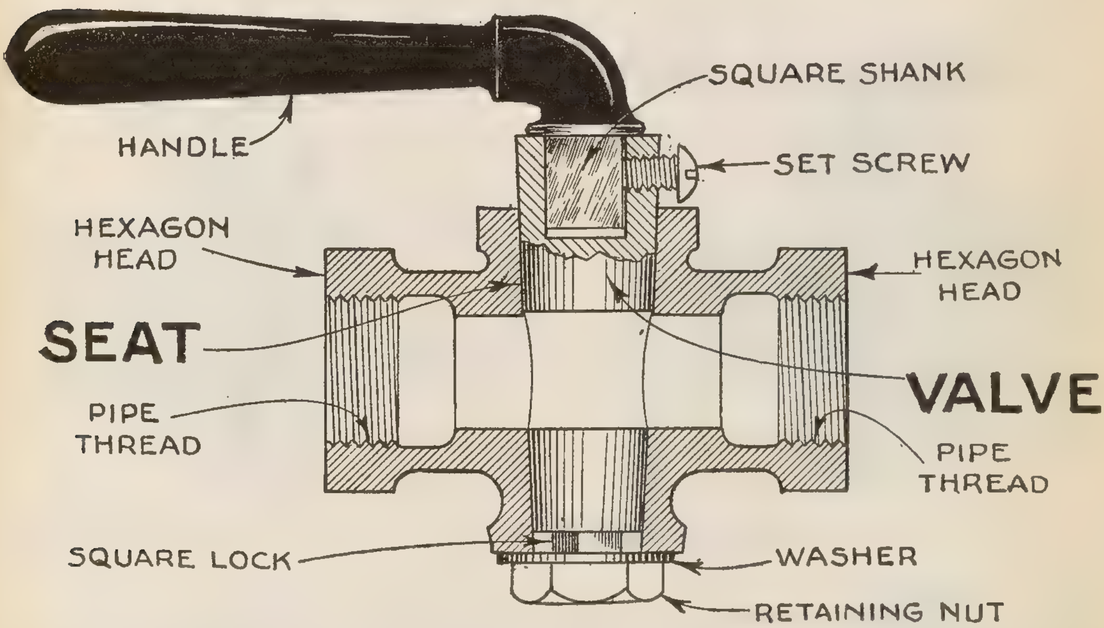


FIG. 7,299.—Straight way cock showing ends tapped for connection in the run of a pipe line, and detachable handle.

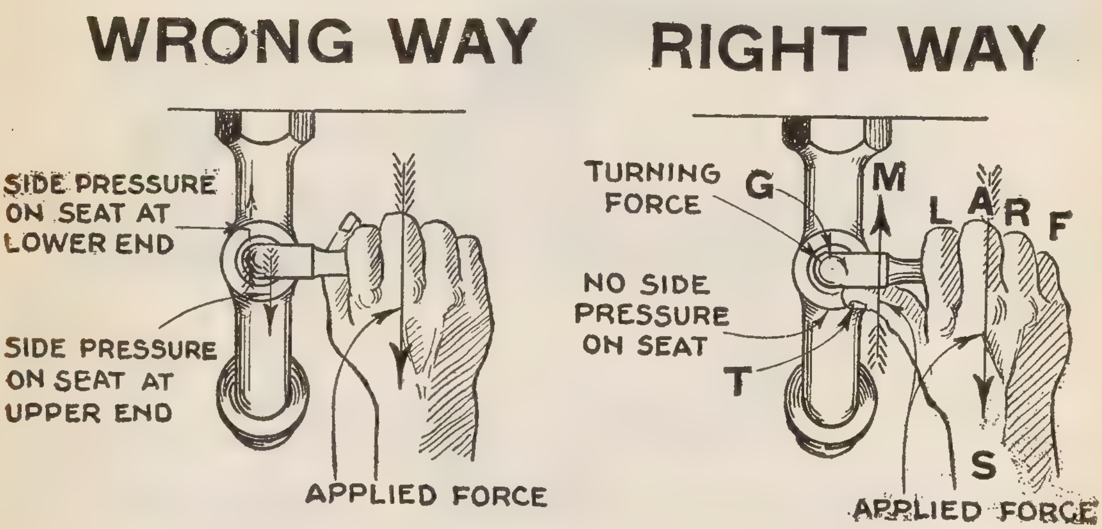
to shut off water from a pipe line in case of repairs or for draining in cold weather.

It is a very good cock that will stand much turning on and off without leaking especially considering the abuse it receives by wrong handling as in fig. 7,300.

Because of this tendency to leakage a pattern of cock having a packed valve is sometimes used such as shown in fig. 7,309.

In order to insure that the cock handle will be turned to the full open or closed positions, some cocks are provided with stops and check pin, the stops being simply projections on the body adjacent to the valve, and the check pin being inserted in the valve so that it will strike against the stops limiting the angular movement of the valve to the proper amount as shown in figs. 7,310 and 7,311.

Three way cocks are used to control the flow at the junction of:



FIGS. 7,300 and 7,301.—Wrong and right way to open a ground key faucet (or cock). Grasping the handle as in fig. 7,300 and simply pulling it toward you brings considerable pressure against the seat and tends to warp or distort seat causing leakage. The handle should be turned as in fig. 7,301, pushing with the thumb T, and pulling with the other fingers **L,A,R,F,** producing forces **M,** and **S.** The force M, prevents side pressure due to **S,** coming on the valve seat giving a resultant turning force **G,** around the valve axis.

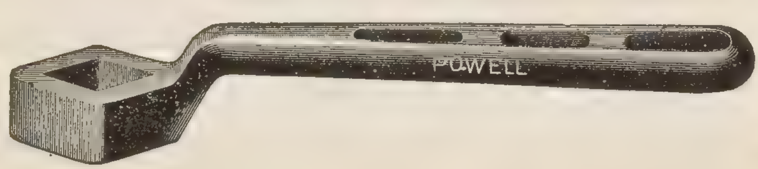
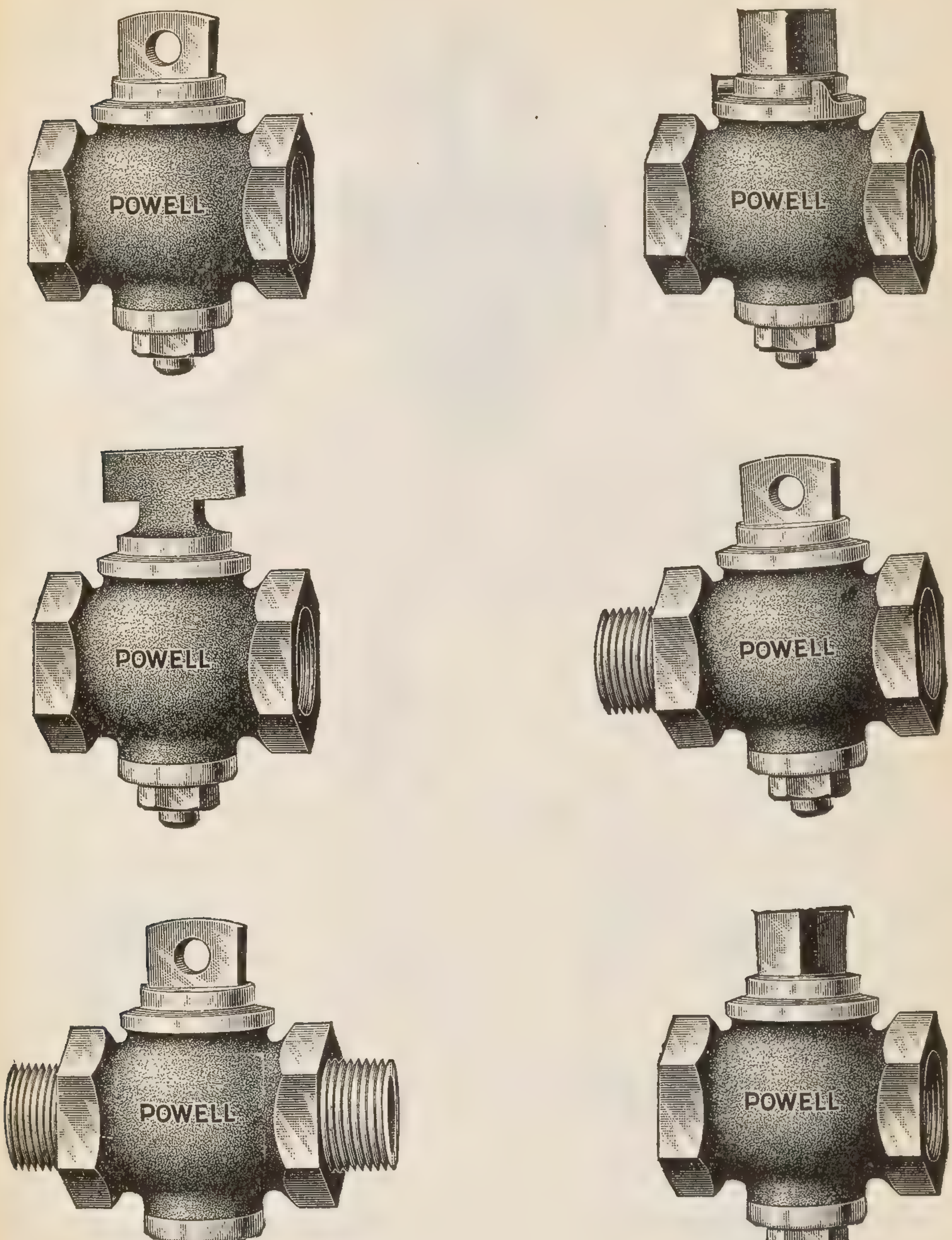


FIG. 7,302.—Powell malleable cock lever or handle for square head cocks.



Figs. 7,303 to 7,308.—Powell plain straight way steam cocks. Fig. 7,303, flat head; fig. 7,304, square head; fig. 7,305, tee head; fig. 7,306, flat head, male and female; fig. 7,307, flat head, both ends male; fig. 7,308, flat head with check pins, both ends female.

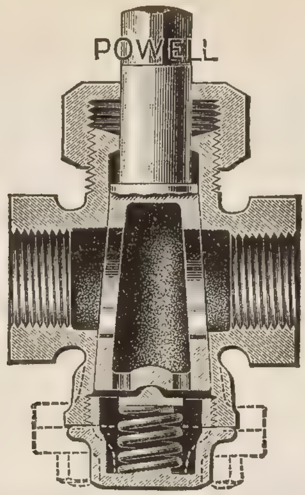
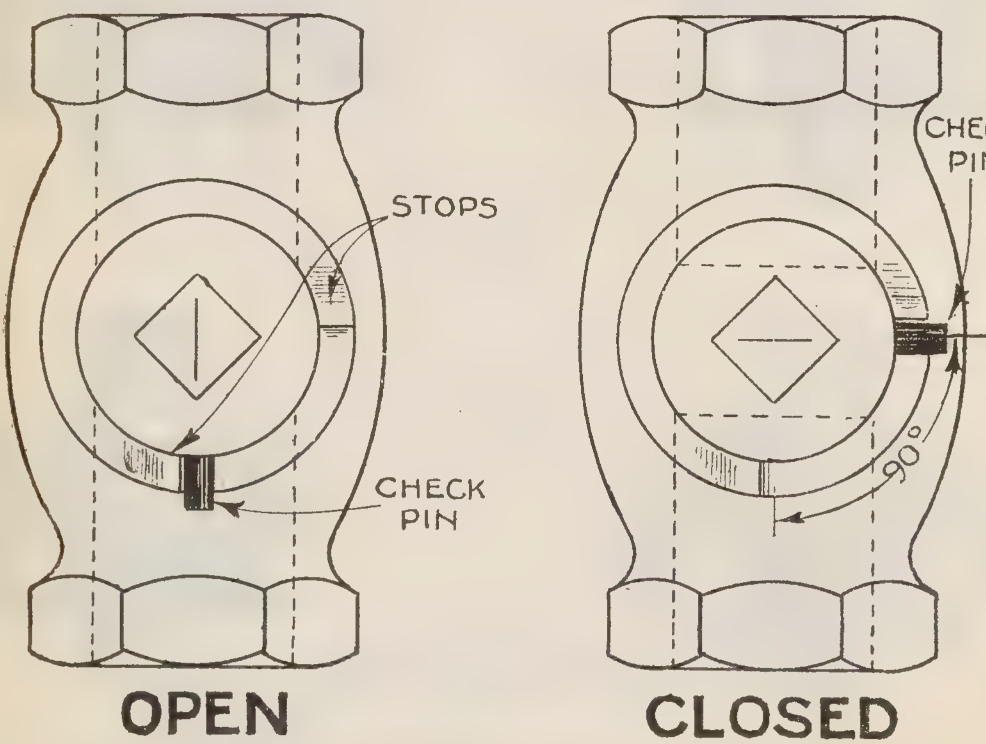
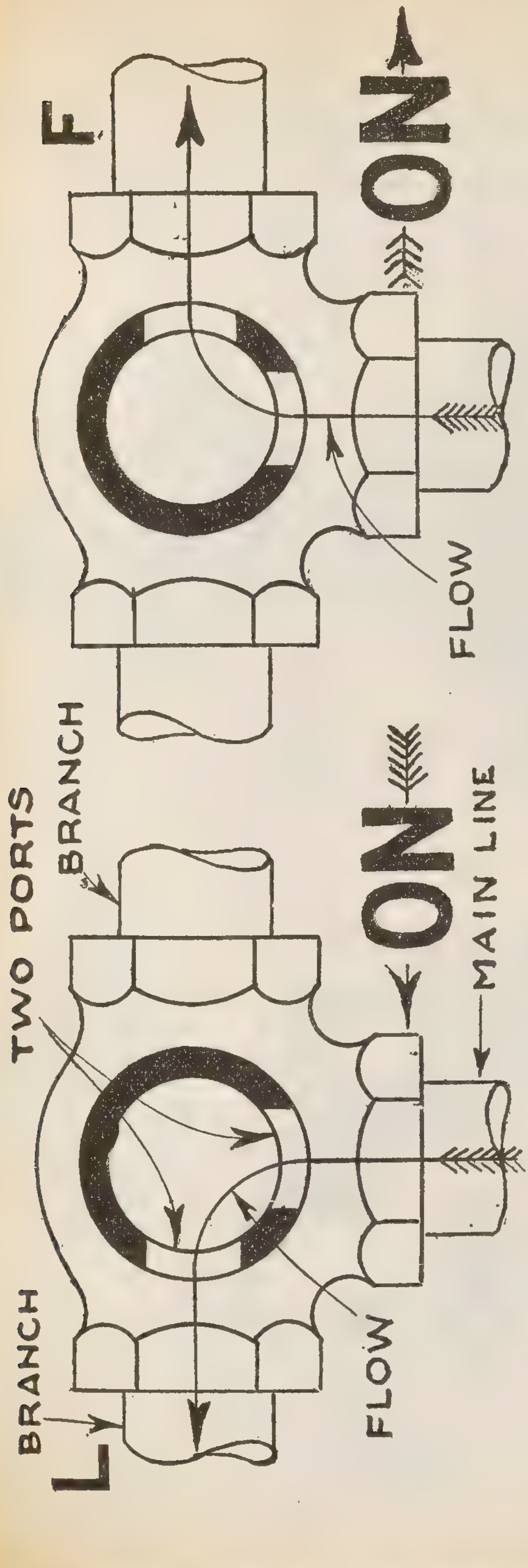
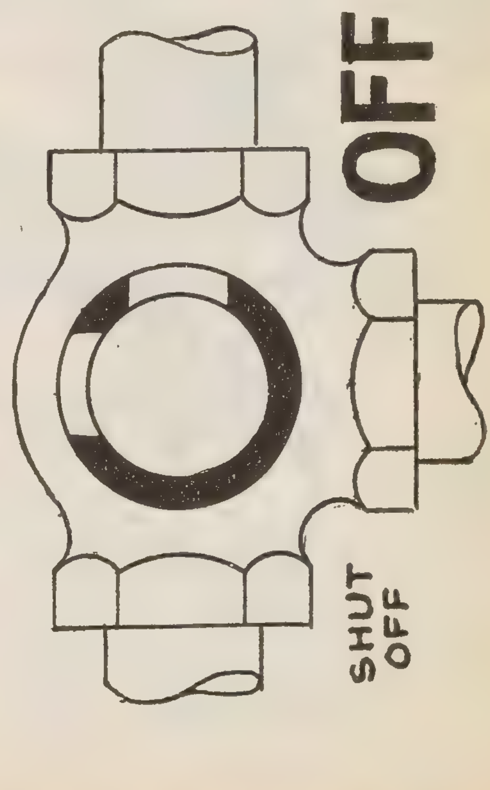


FIG. 7,309.—Powell straight way packed valve steam cock for working pressures up to 200 lbs. ***In construction,*** the valve is passed up through the bottom of this stop cock, the reverse of the usual way, and is held to its bearing by a spring in the bottom cap. Holes are drilled in bottom of key, allowing fluid to act as a cushion. The stem is provided with the usual packing nut. Care must be observed not to get the packing too tight—it may throw the valve off its seat. These cocks are made with screw bottom nut up to 1¼ in., 1½ in. and larger with bolted flange nuts, as indicated ir dotted lines.

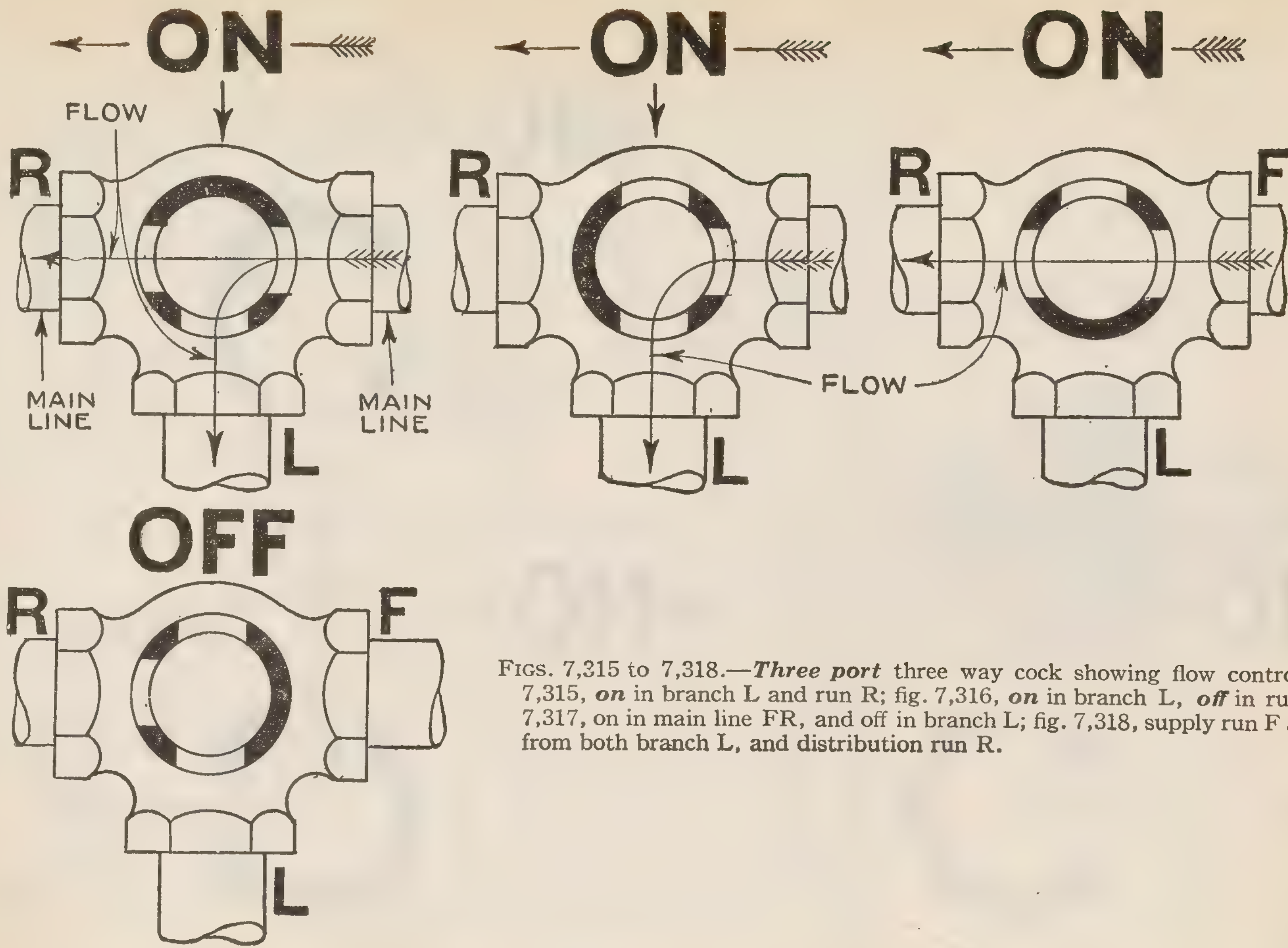


FIGS. 7,310 and 7,311.—Straight way cock with stops and check pin in *open* and *closed* positions. This control device is especially desirable on three way, and waste cocks.





FIGS. 7,312 to 7,314.—***Two port*** three way cock showing flow control. Fig. 7,312, ***on*** in branch L; fig. 7,313, ***on*** in branch F; fig. 7,314, water shut off from both branches.



FIGS. 7,315 to 7,318.—***Three port*** three way cock showing flow control. Fig. 7,315, ***on*** in branch L and run R; fig. 7,316, ***on*** in branch L, ***off*** in run R; fig. 7,317, on in main line FR, and off in branch L; fig. 7,318, supply run F ***shut off*** from both branch L, and distribution run R.

1. A main line and two branch lines.
2. A main line and one branch line.

For the first mentioned case a two port three way cock is used. As shown in figs. 7,312 to 7,314, the water may be directed to either branch or shut off from both. Where there is only one branch, the three port cock will permit control of flow to branch and to run of main line beyond cock as shown in figs. 7,315 to 7,318.

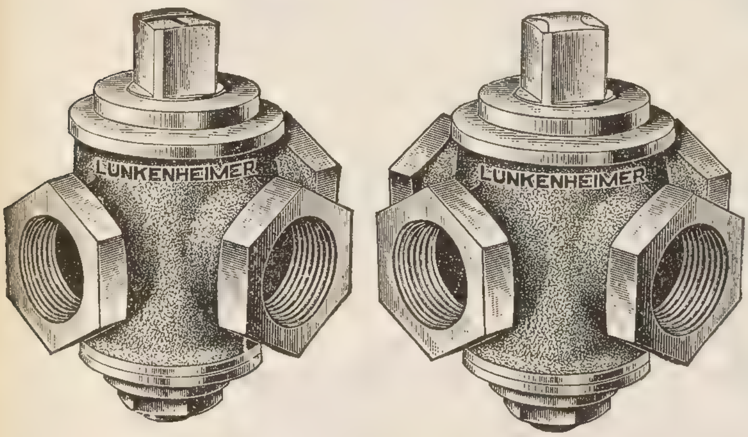
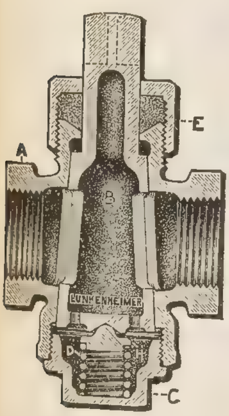


Fig. 7,319 shows the general appearance of three way cocks having female screw ends and square heads, and fig. 7,320, a four way cock also having female screw ends.

FIG. 7,319 and 7,320.—Lunkenheimer three, and four way steam cocks with female screw ends for 150 lbs. working steam pressure. The position of ports through valves (called *keys* by the trade) is indicated on top of square head as can be seen. Can be had with either two or three port key.



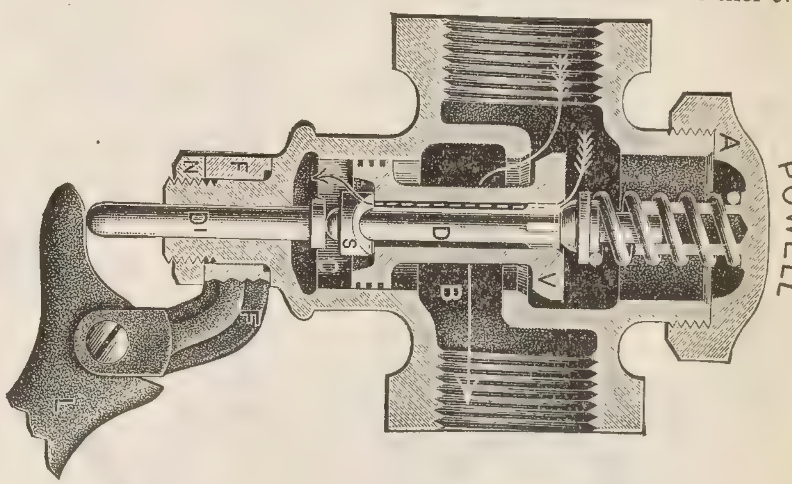
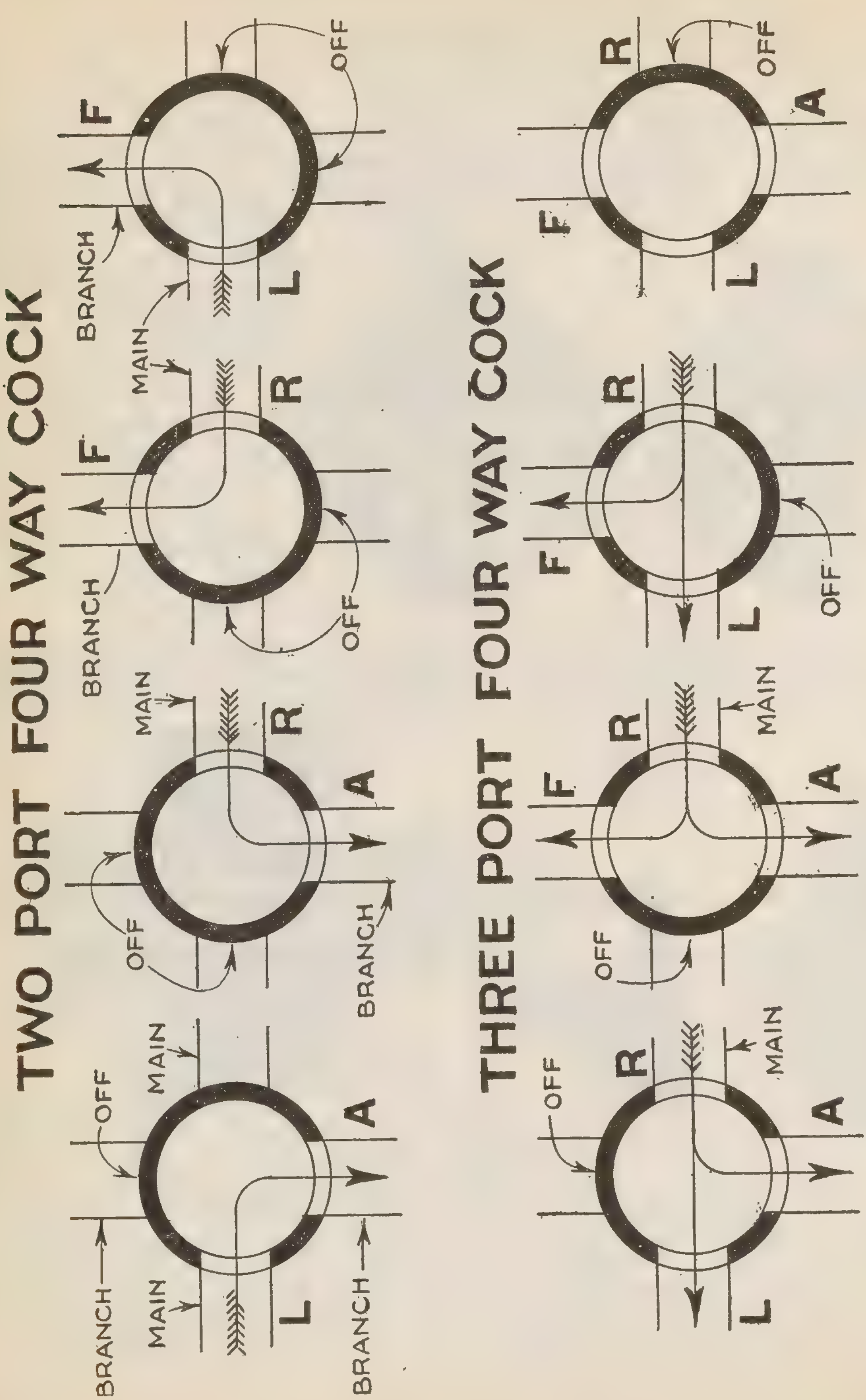


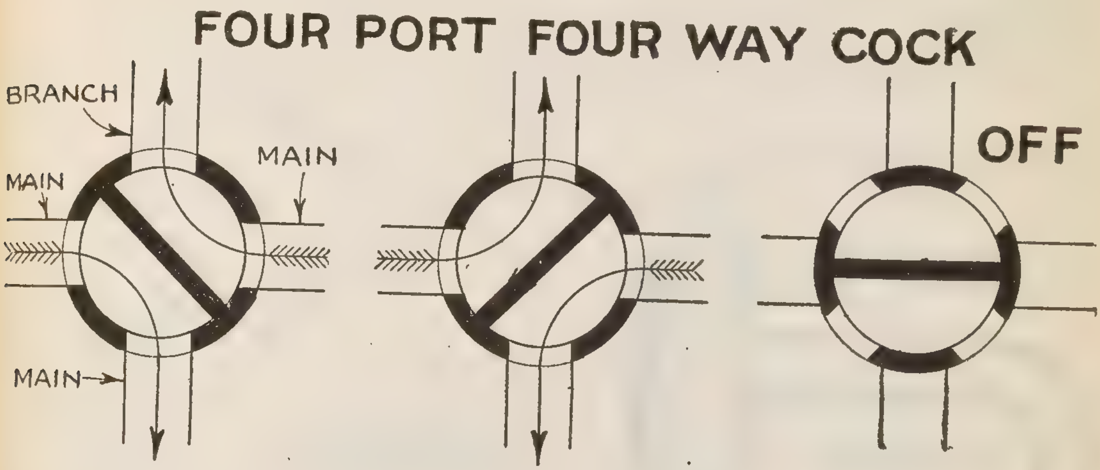
FIG. 7,321.—Lunkenheimer straightway padded key stop cocks for 150 lbs. pressure.

FIG. 7,322.—Powell balanced whistle valve. ***In operation,*** steam enters at the left hand of body B, the pressure being on top of valve V. Pulling down the lever L, raises the stem D, and D1, off its seat, admitting steam through the shank of valve V, completely filling balancing chamber C, equalizing the pressure. The main valve V, is moved full open with but very slight effort, the arrows, showing movement of steam, readily explain the operation of the valve. A, is valve bonnet with projecting hollow stud which serves as a guide for lower stem of auxiliary valve D, and also carries the spring which keeps this valve home to its seat. N, is lock nut holding fulcrum C, in position.



FIGS. 7,323 to 7,330.—Four-way ***two port*** cock flow control diagrams.
FIGS. 7,331 to 7,333.—Four-way ***three port*** cock flow control diagrams.

The range of flow control with a four way cock is quite varied as this pattern may be had with either two, three, or four port valve. The flow control with these different valves is shown in the skeleton diagrams, figs. 7,323 to 7,333.



FIGS. 7,331 to 7,333.—Four way four port cock control diagrams.

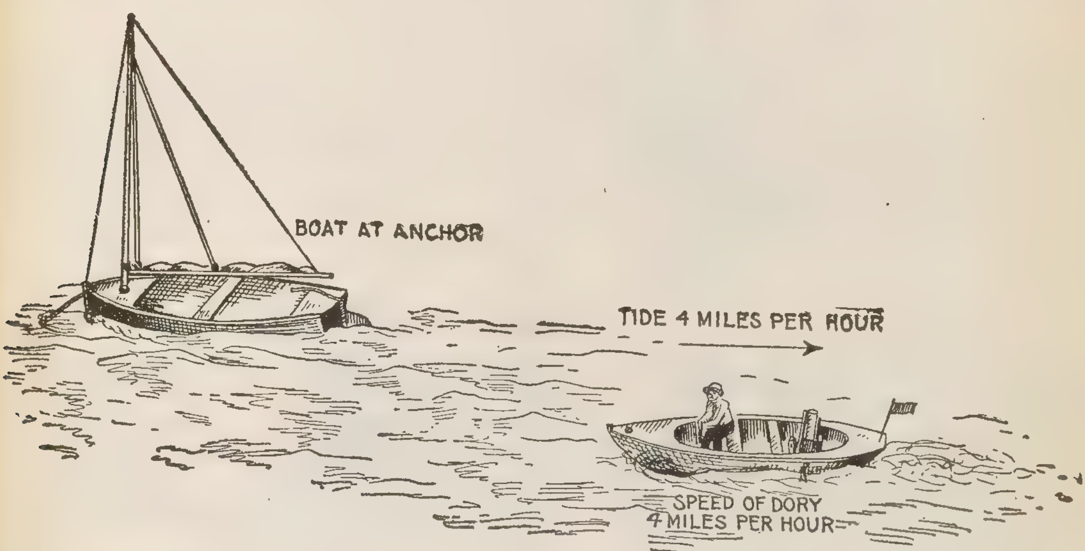
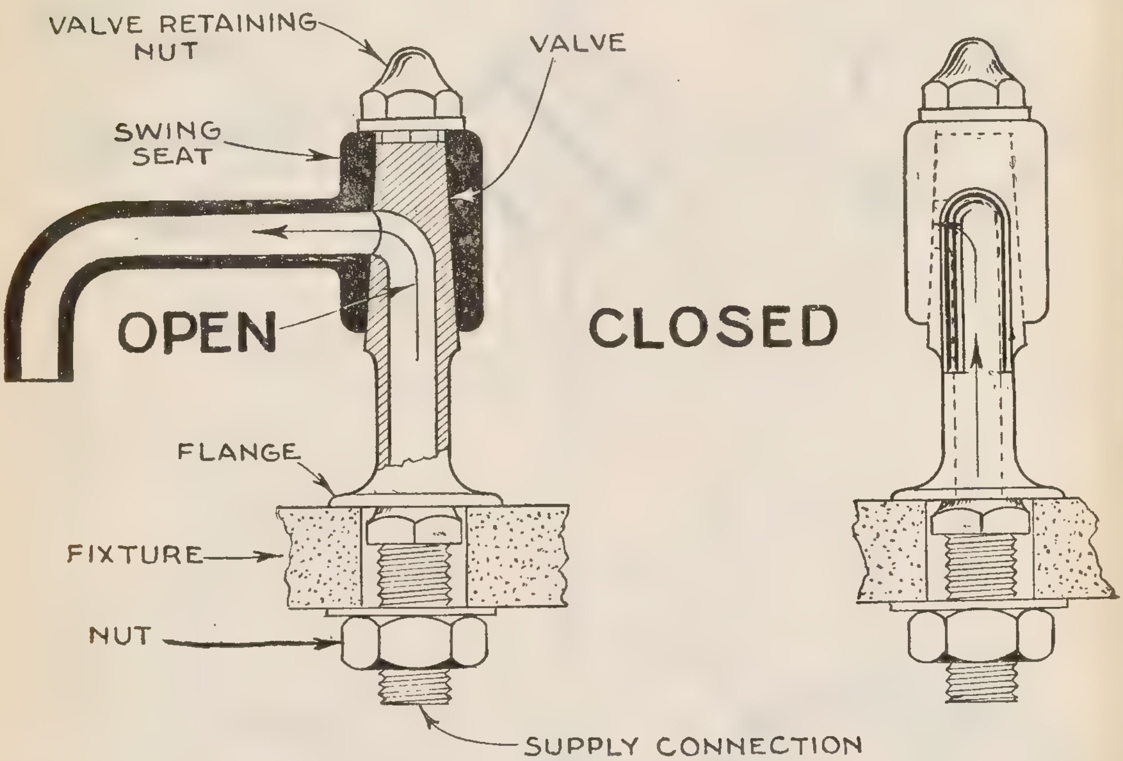


FIG. 7,334.—Marine view, showing that *motion is purely a relative matter*. In order that there may be motion something must be regarded as being stationary. ***The small craft*** running at a speed of four miles per hour against the current is *moving* at that velocity *relative* to the current, yet is at a standstill relative to the cat boat. In this instance both cat boat and dory are moving with respect to the water if the latter be regarded as stationary. Again if the earth be regarded as being stationary, the two boats are at rest and the water is moving relative to the earth. Hence, with respect to flow control of water, it makes no difference if the valve of a faucet (or COCK) move as in figs. 7,292 and 7,293, or the seat move, as in figs. 7,335 and 7,336.

The so called swing cock (as it is generally known) *is **properly speaking** a faucet,* as it controls flow from an outlet as shown in figs. 7,335 and 7,336, and not along the run of a pipe line.

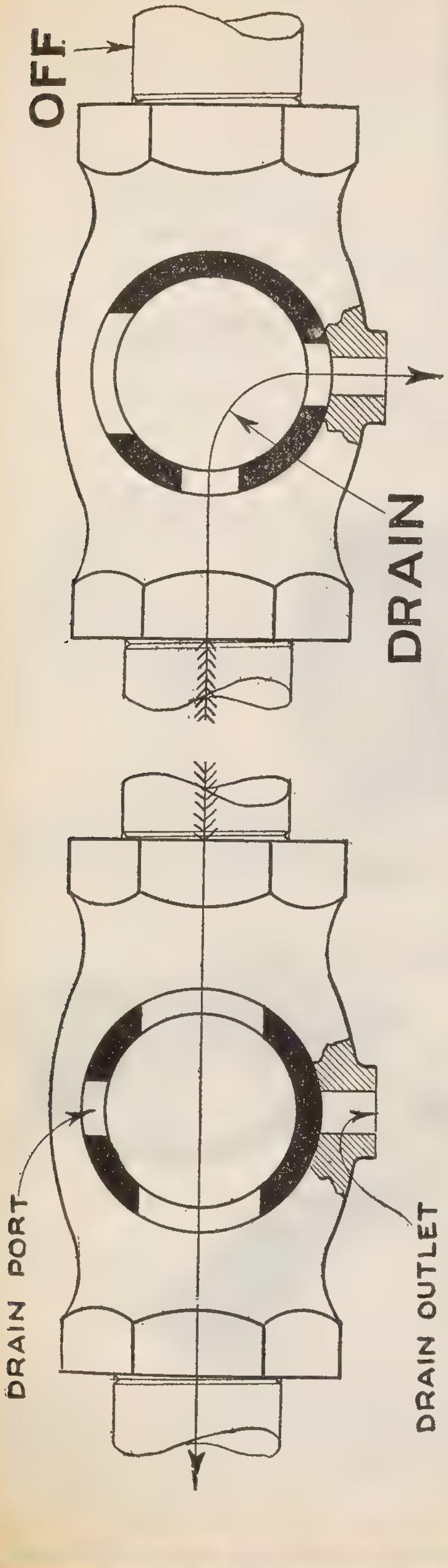
It is a form of cock in which the valve is stationary and the seat move-



FIGS. 7,335 and 7,336.—Swing faucet or so called swing cock in ***open*** and ***closed*** positions. ***In construction,*** the conical ground joint valve forms the body of the faucet being rigidly attached to the fixture and connected to the supply pipe at its lower end. The seat is arranged to swing or turn on the valve and is provided with a spout so that ***in operation,*** to turn on the water the spout is turned about 90° till it faces the center of the bowl which brings the seat and valve parts in line, thus permitting the flow of water. Since motion "*is purely a relative matter*" (see fig. 7,334) evidently it makes no difference whether the valve, or the seat move with respect to the fixture.

able, the reverse of the usual construction and is a satisfactory lavatory faucet where clean water is used.

In addition to shutting off the flow from a line, an important duty is to drain the line from which the water was shut off.



FIGS. 7,337 and 7,338.—Waste or drain cock showing operation; Fig. 7,337, **ON** position, water flowing through run; fig. 7,338, **OFF** position, distribution end of run draining through drain port and drain outlet.

This is accomplished with a straight way cock by using a valve, provided with a small or auxiliary port at right angles to the two main ports with drain outlet at the side of the faucet. The operation of this type cock is shown in fig. 7,337 and 7,338.

Waste or drain cocks should always be used to protect exposed lines in freezing weather so that they may be conveniently shut off and drained in one operation.

Corporation cocks are *special forms of cock used to shut off the water supply from a city main to a house main.*

The cock is tapped into the city main, and connected with the house line by a lead "goose neck" or bent length of lead pipe to protect the cock from any strain due to movement of the house pipe by expansion or construction. The cock and connection are shown in fig. 0,217.

NOTE.—***Ground key cocks.***—Ground key work may be either stop cocks for controlling water in a pipe, or faucets for drawing water at a fixture. The only difference is in their exterior appearance, the principles of construction and operation being the same for both patterns. Ground key cocks can be had for lead pipe, for iron pipe, and, in the case of stop cocks, they may be had with one end threaded for iron pipe, and the other end prepared for lead pipe. Cocks for iron pipe can be had tapped with female threads or threaded to screw in a fitting.

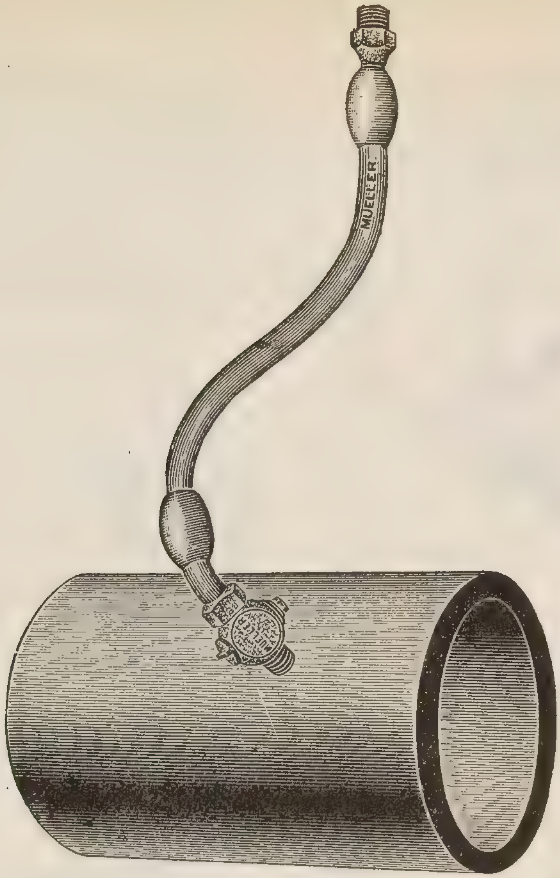
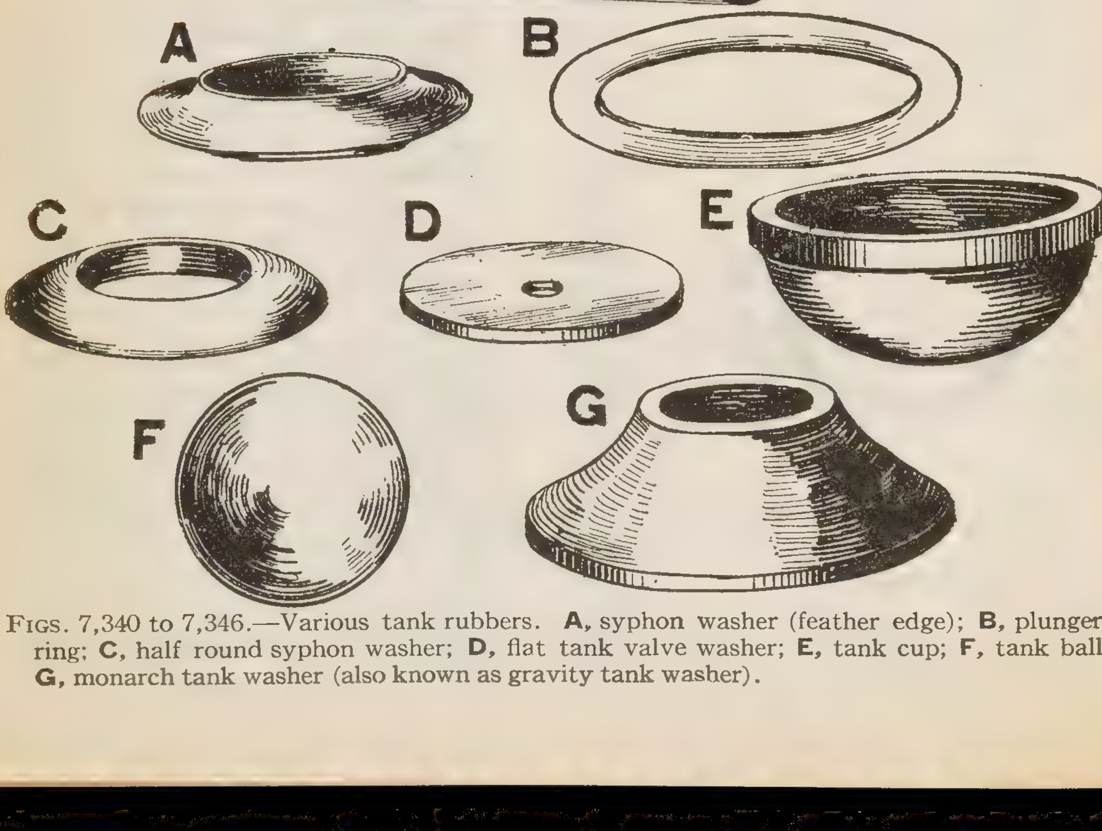
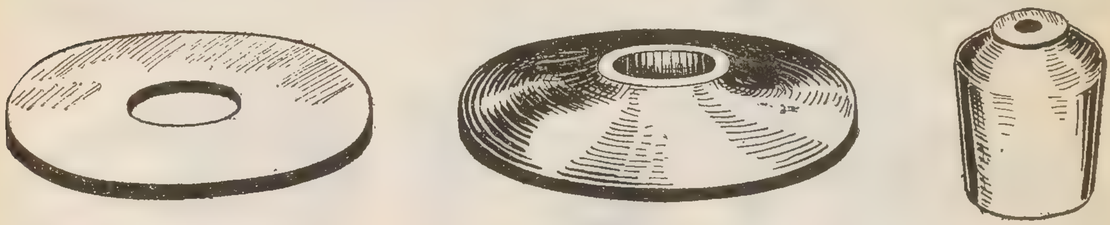


FIG. 7,339.—Corporation cock and connection between cock and house main.

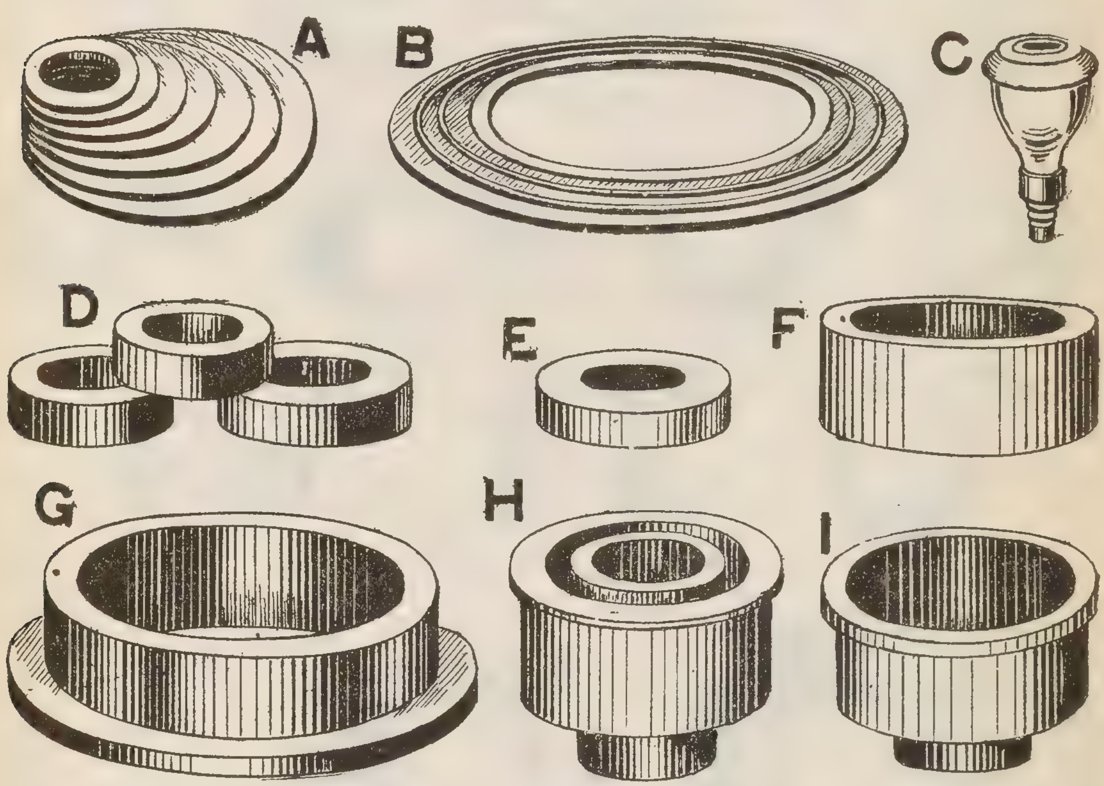


FIGS. 7,340 to 7,346.—Various tank rubbers. **A**, syphon washer (feather edge); **B**, plunger ring; **C**, half round syphon washer; **D**, flat tank valve washer; **E**, tank cup; **F**, tank ball; **G**, monarch tank washer (also known as gravity tank washer).

Rubber Accessories.—There is a great multiplicity of washers, valves, gaskets, connections, packings, etc., made of

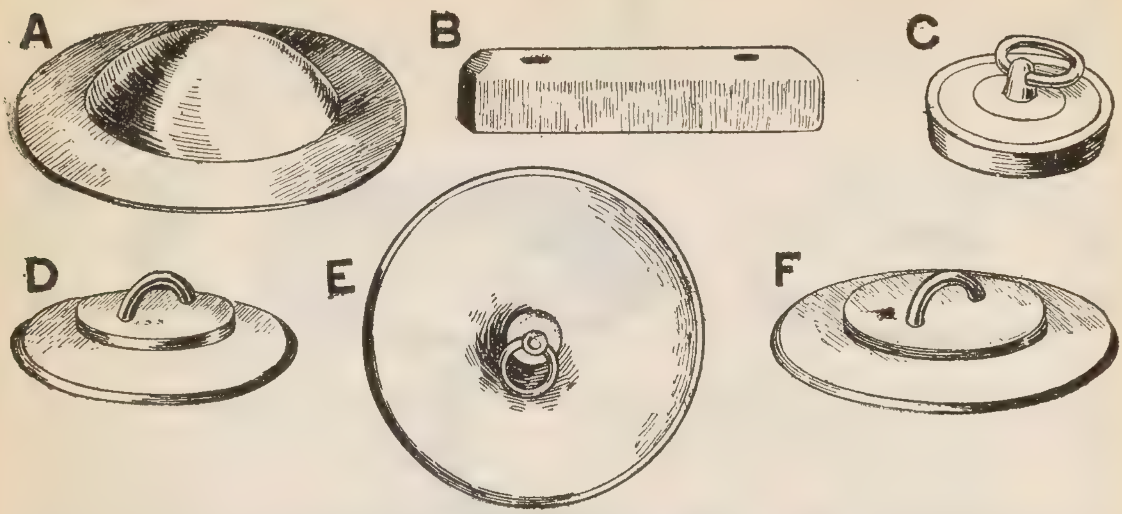


Figs. 7,347 to 7,349.—Various faucet washers or valves. Fig. 7,347, flat; fig. 7,348, beveled; fig. 7,349, acorn, or so called Fuller ball.

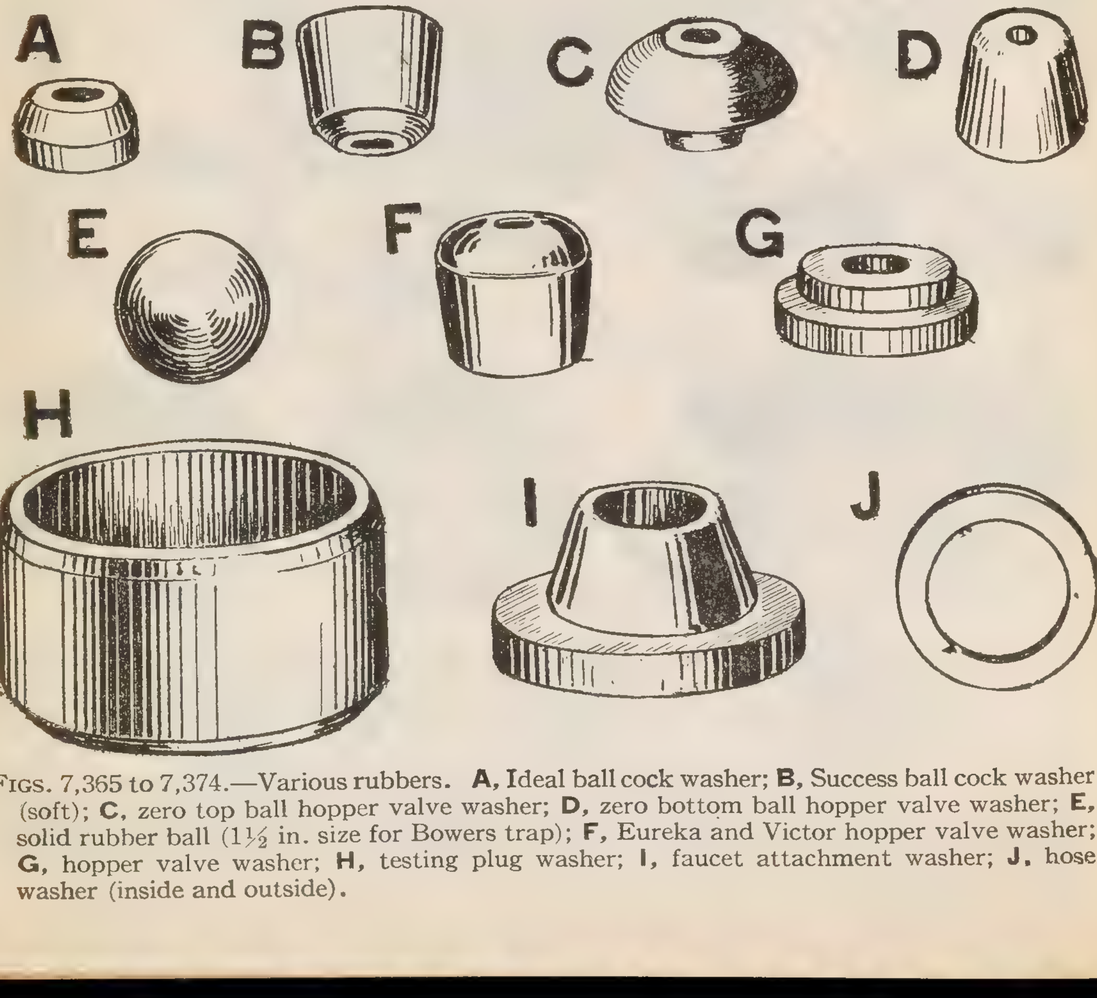


Figs. 7,350 to 7,358.—Various rubbers. **A,** union washers; **B,** closet gasket; **C,** faucet attachment for shower spray; **D,** valve disc; **E,** glass gauge washer; **F,** plain spud washer; **G,** flanged spud washer; **H,** Robbs hopper connection; **I,** "Dandy" hopper connection.

rubber. These are shown in the accompanying illustrations and the methods of using them with the fitting or fixture for which they are intended.

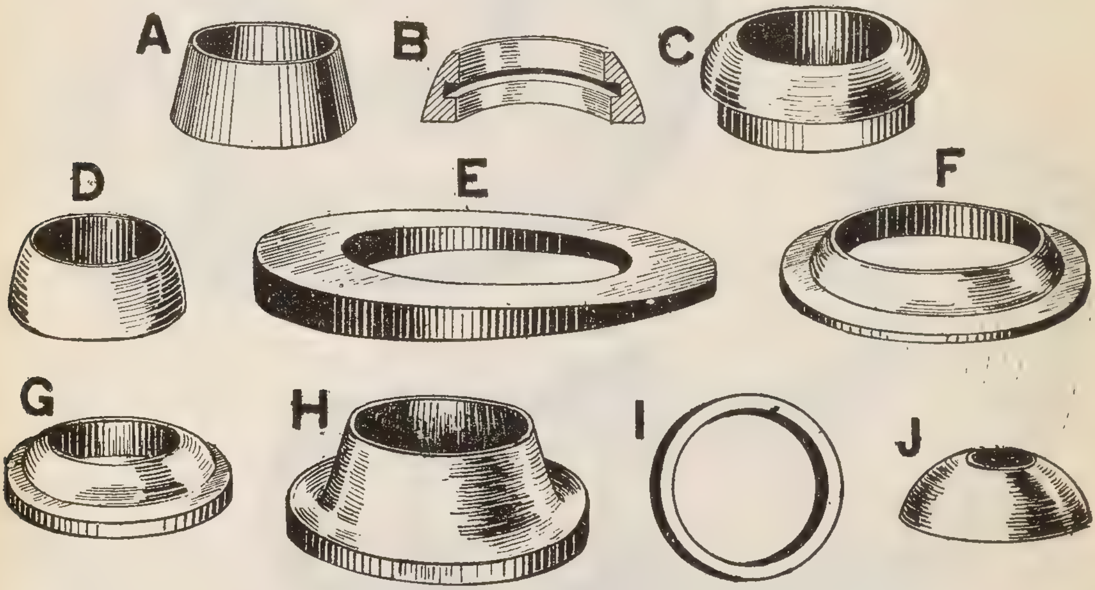


FIGS. 7,359 to 7,364.—Various rubbers. **A,** diaphragm (made of rubber with two ply duck insertion); **B,** oblong bumper; **C,** solid stopper; **D,** basin suction stopper; **E,** sink suction stopper; **F,** bath suction stopper.



FIGS. 7,365 to 7,374.—Various rubbers. **A,** Ideal ball cock washer; **B,** Success ball cock washer (soft); **C,** zero top ball hopper valve washer; **D,** zero bottom ball hopper valve washer; **E,** solid rubber ball (1½ in. size for Bowers trap); **F,** Eureka and Victor hopper valve washer; **G,** hopper valve washer; **H,** testing plug washer; **I,** faucet attachment washer; **J.** hose washer (inside and outside).

Plumbers' Brass Tubing.—For bars, waste piping, railings, etc., nickel plated brass tubing is largely used, because of its appearance and the light duty it receives permits a lighter tube than regular wrought pipe sizes.



FIGS. 7,375 to 7,384.—Various rubbers. **A** to **D**, waste washers; **E**, waste and overflow washers; **F**, bath gasket; **G**, basin gasket; **H**, sink gasket; **I**, square slip joint washer; **J**, seat hinge washer.

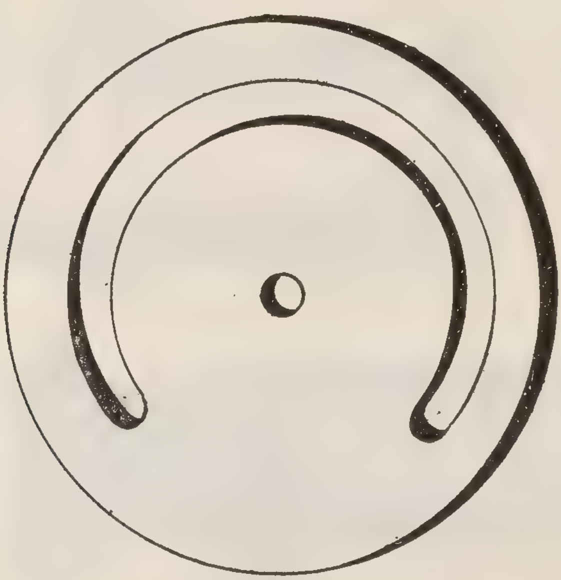
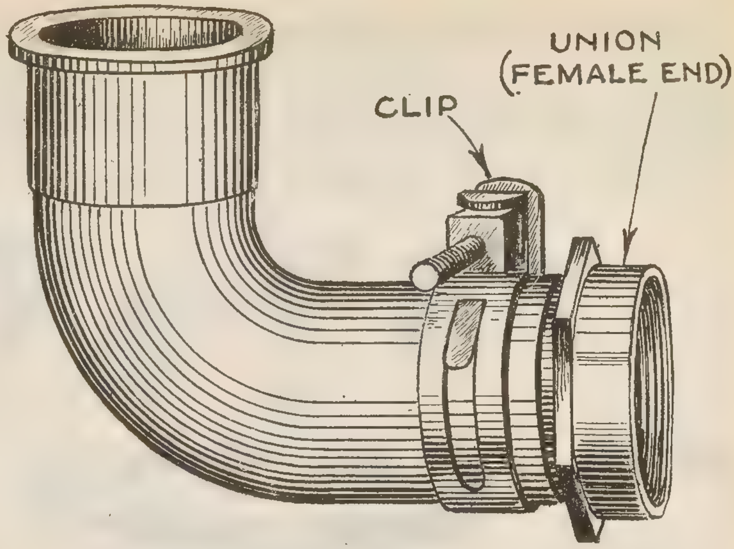


FIG. 7,385.—Leather pump washers.

FIG. 7,386.—Climax rubber elbow.



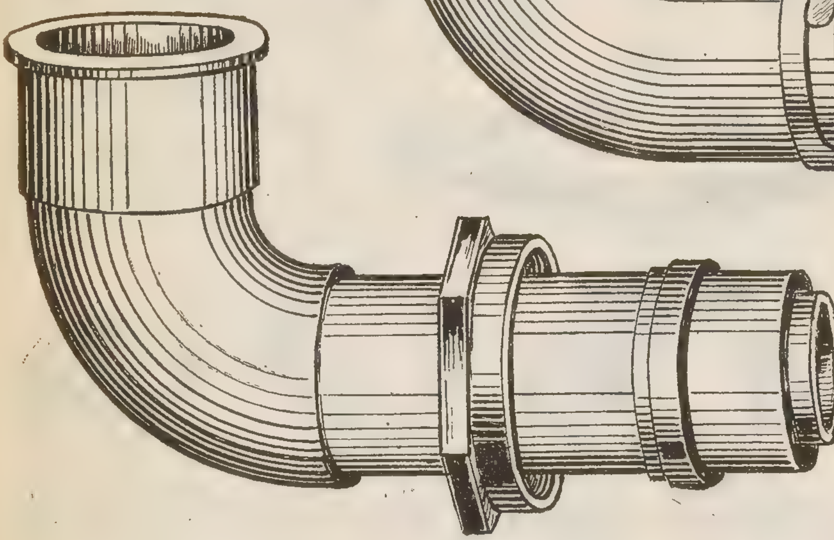
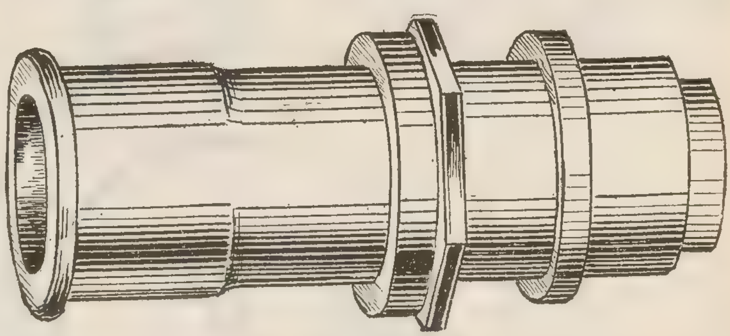


FIG. 7,387.—Fleck long rubber elbow.

FIG. 7,388.—Straight rubber connection.



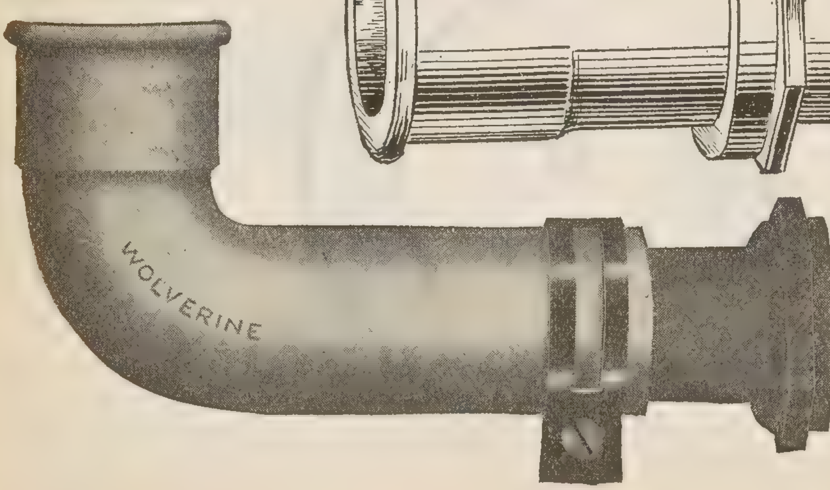


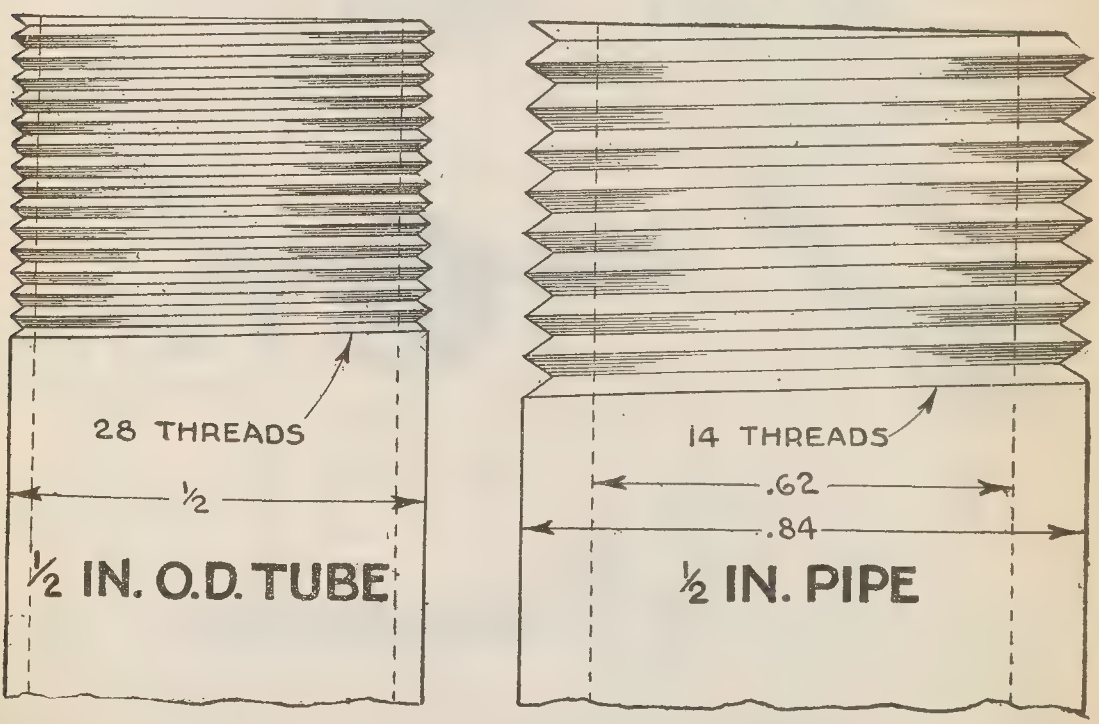
FIG. 7,389. — Wolverine large rubber elbow.

The usual stock lengths of the above tubes are 3 and 6 ft. Owing to the thinness of the tubes finer threads are used than on regular wrought pipe. Note very carefully the difference in the number of threads on plumbers' tubing and on wrought pipe, as given in the following table:

Comparison of Threads

Diameter	½	⅝	¾	⅞	1	1¼
	Threads per inch					
Tubing	28	20	20	18	18	18
Pipe	14		14		11½	11½

Pipe is not made in the ⅝ and ⅞ in. sizes.

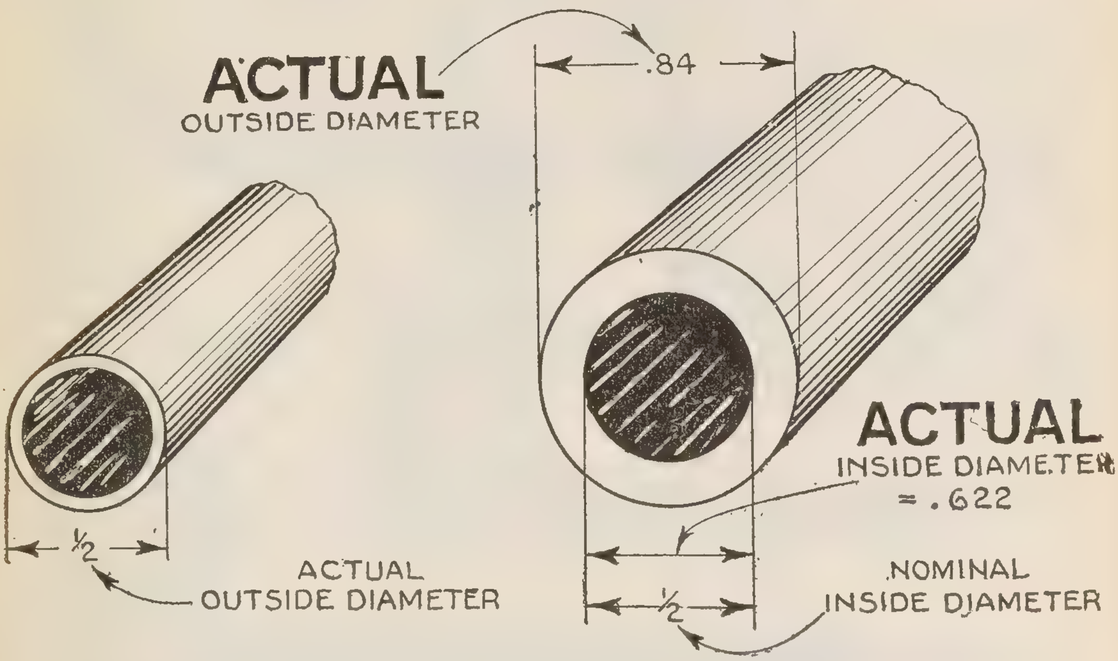


FIGS. 7,390 and 7,391.—Comparison of threads on plumber's tubing and wrought pipe. ***It is surprising*** how many mechanics there are who don't know *the difference between a* ***pipe*** *and a* ***tube.***

The size of a tube as given corresponds to its ***outside diameter*** rather than a nominal diameter as with wrought pipe. The following are the sizes and thicknesses generally used:

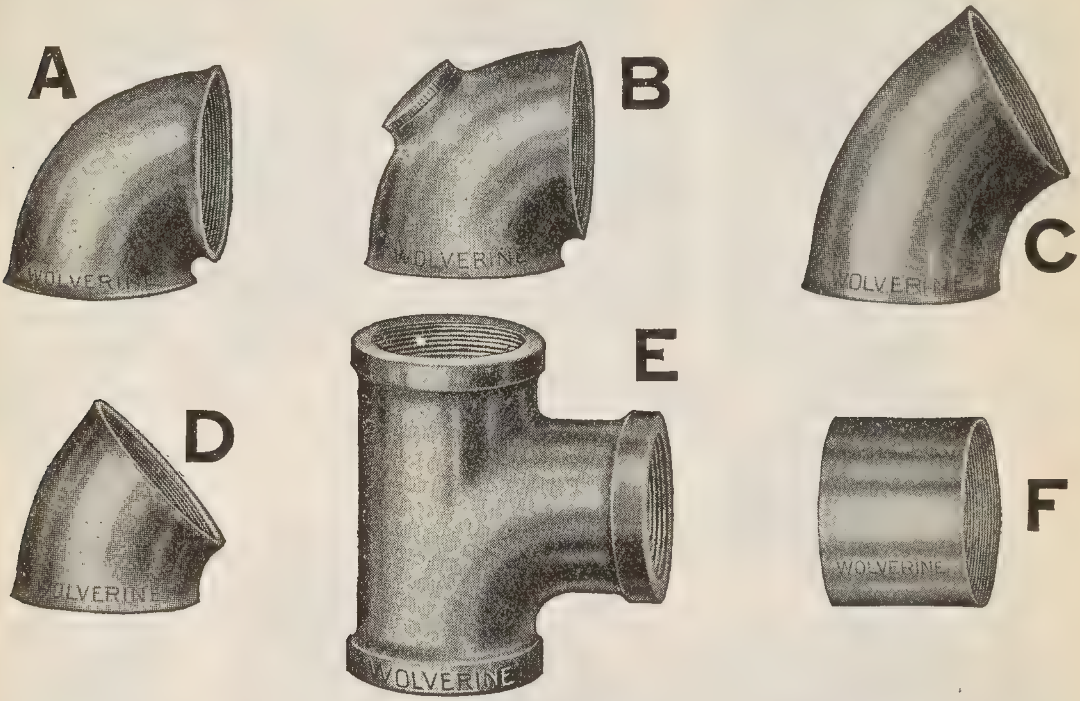
Nickel Plated Brass Tubing

Outside diameter.......	3/8	1/2	5/8	3/4	7/8	1	1 1/8
Gauge.................	20	20	20	20	20	20	20
Outside diameter.......	1 1/4	1 3/8	1 1/2	2	1 1/4	1 3/8	1 1/2
Gauge.................	20	20	20	20	17	17	17



FIGS. 7,392 and 7,393.—Comparison of plumber's brass tubing and wrought pipe. Note the sizes of tubing are specified by the ***actual*** outside diameter, and wrought pipe by the ***nominal*** *inside diameter*. The illustrations show ½ in. (*o.d.*) tubing and what is known as ½ in. wrought pipe. In fig. 7,393, it is seen that the inside diameter of the pipe (standard weight) is not ½ in. but .622 in., the pipe simply being known as ½ in. pipe. For extra heavy and double extra heavy ½ in. pipe, the inside diameters are .546 and .252 in. respectively. On larger sizes standard wrought pipe (1 in. and up) the difference between the ***nominal*** and ***actual*** inside diameter is not so great.

Fine Thread Fittings.—These fittings are made of brass nickle plated and differ from malleable iron fittings in being of



FIGS. 7,394 to 7,399.—Plumber's fine thread fittings; brass nickel plated. **A,** 90° elbow; **B,** 90° elbow with cleanout; **C,** 60° elbow; **D,** 45° elbow; **E,** sanitary tee; **F,** coupling.

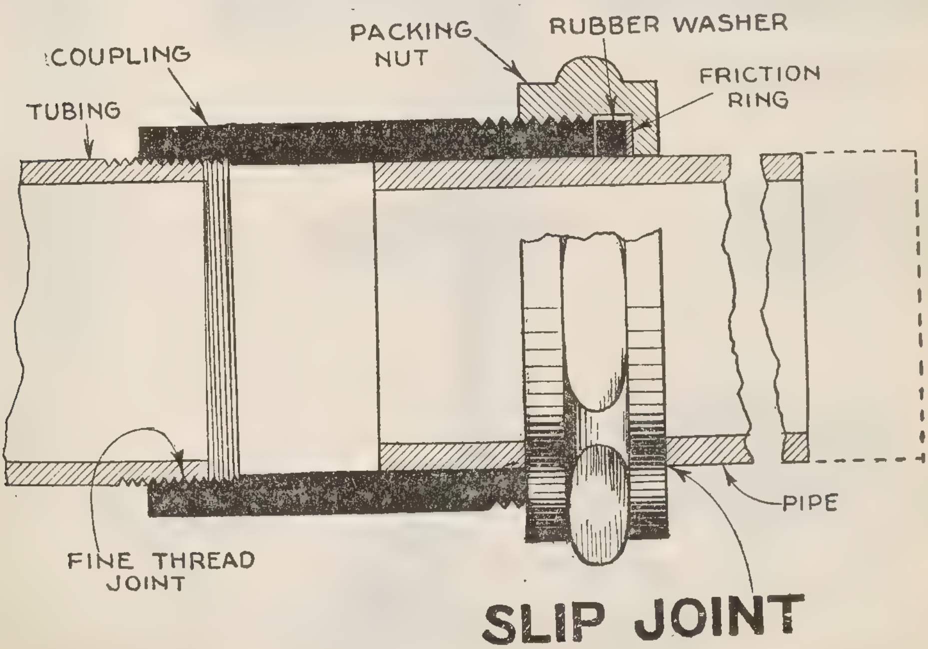
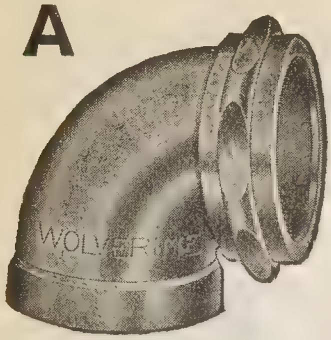
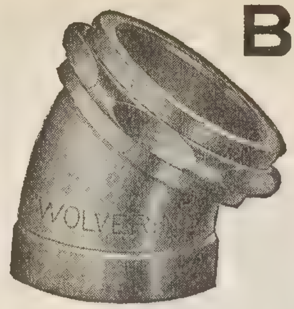


FIG. 7,400.—Fine thread coupling with slip joint illustrating construction of the slip joint.

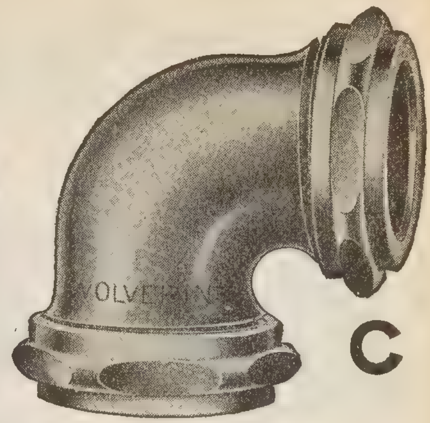
A



B



C



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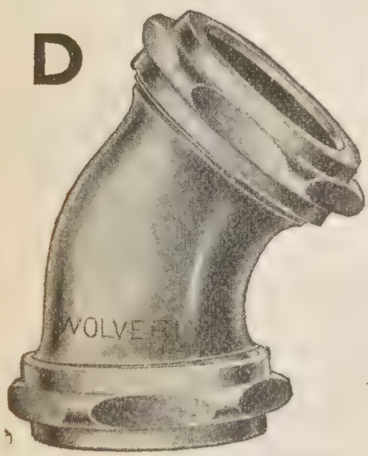
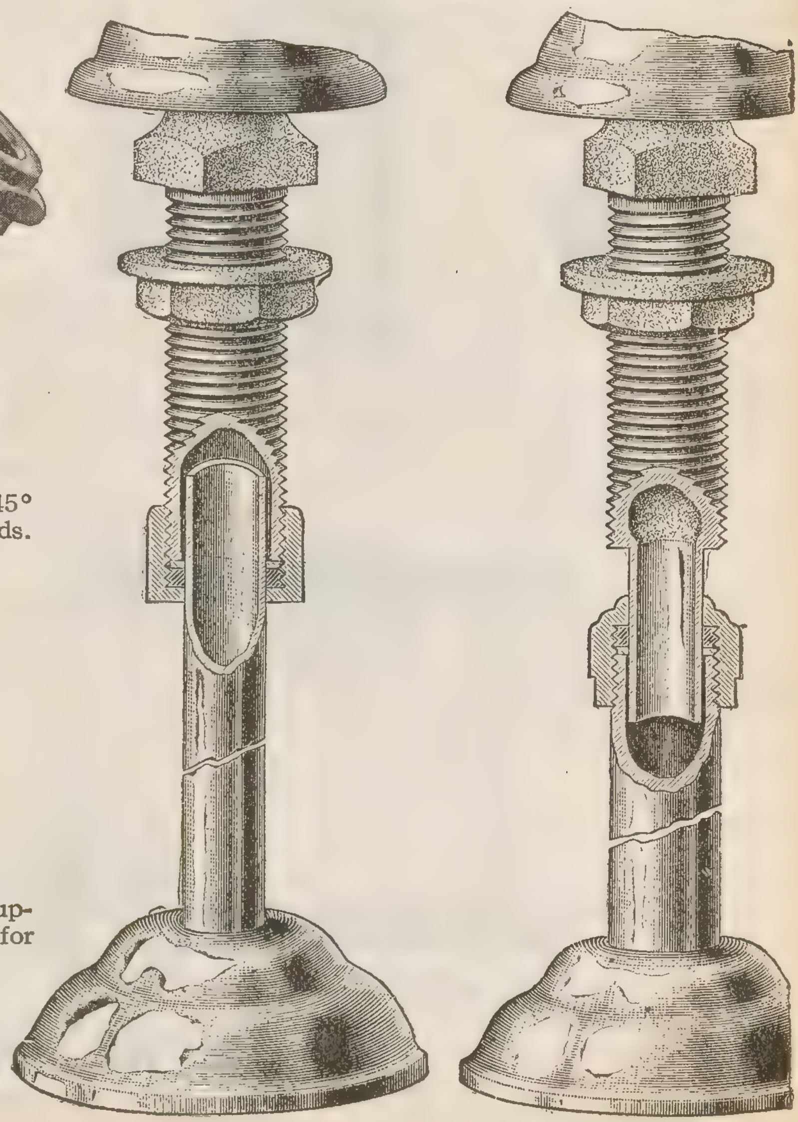
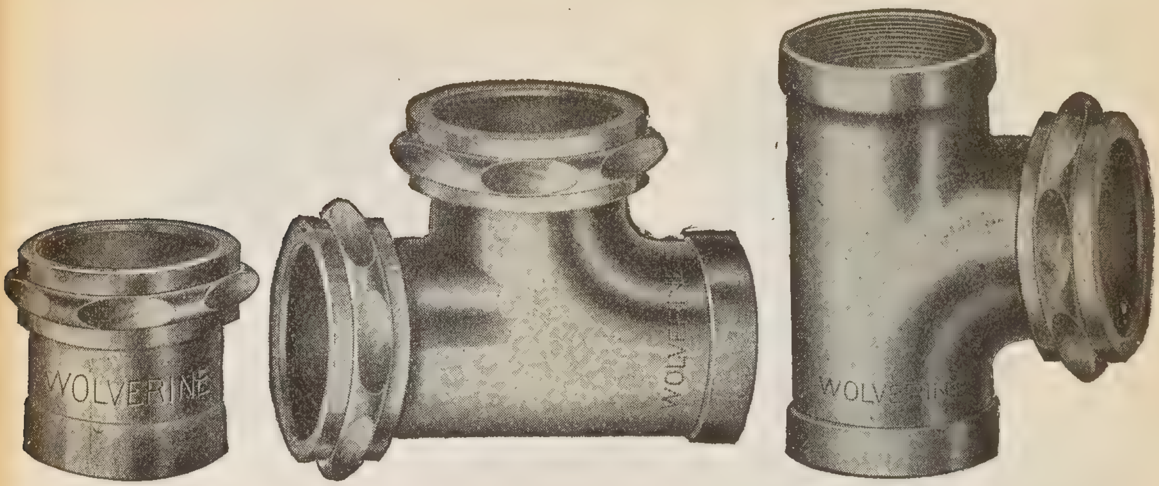


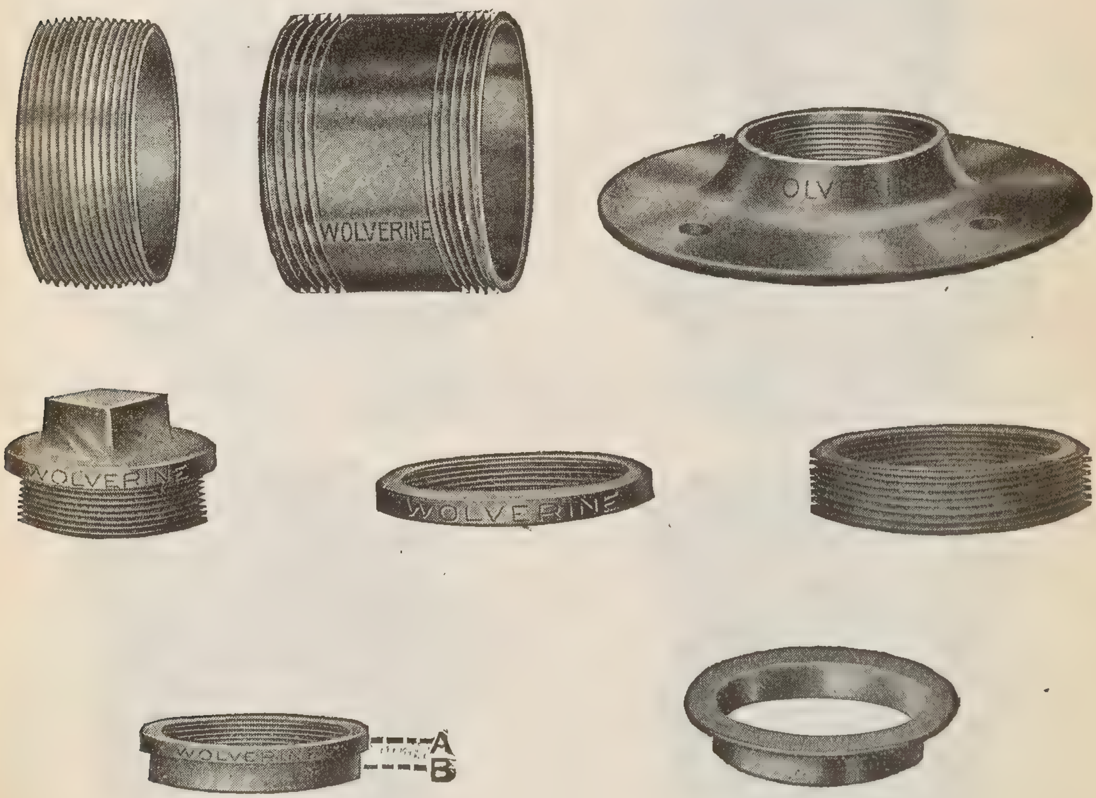
FIGS. 7,401 to 7,404.—Slip joint fittings. 1. **A** and **B**, 90° and 45° elbows, threaded one end, slip joint other end; **C** and **D**, 90° and 45° elbow slip joints both ends.



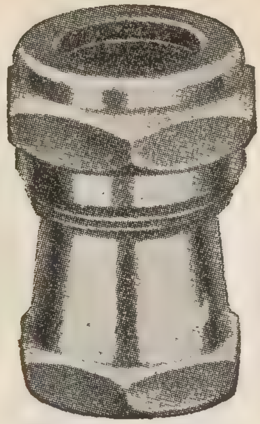
FIGS. 7,405 and 7,406.—Supply slip joint connections for basin or pantry cocks. Fig. 7,405, drilled shank; fig. 7,406, solid tail piece.

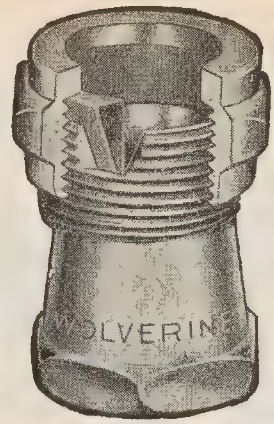


FIGS. 7,407 to 7,409.—Wolverine Slip joint fittings. 2. Fig. 7,407, coupling threaded one end, slip joint other end; fig. 7,408, sanitary tee, one end of run threaded; fig. 7,409, sanitary tee, both ends of run threaded.

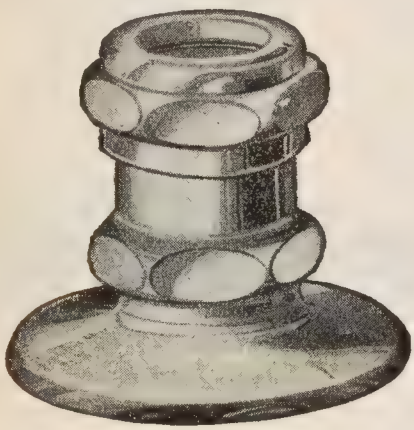


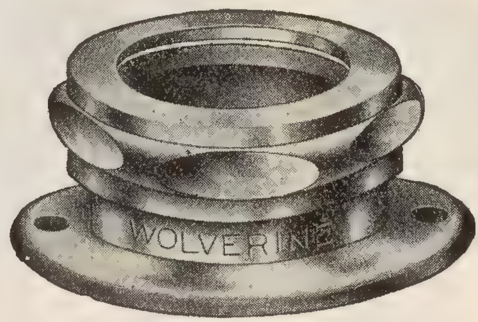
FIGS. 7,410 to 7,417.—Wolverine fine thread fittings. 3. Fig. 7,410, close nipple; fig. 7,411 space nipple; fig. 7,412, flange; fig. 7,413, plug; fig. 7,414, collar; fig. 7,415, bushing; fig. 7,416, collar with shoulder; fig. 7,417 stamped collar with solder joint.



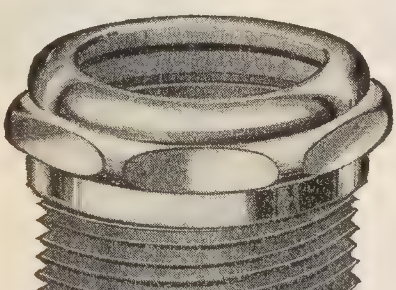


Figs. 7,418 and 7,419.—Wolverine slip joint connections. Fig. 7,418, slip joint for wrought pipe size; fig. 7,419, slip joint for tubing. The sectional view shows tapered seat, cone packing and friction ring.

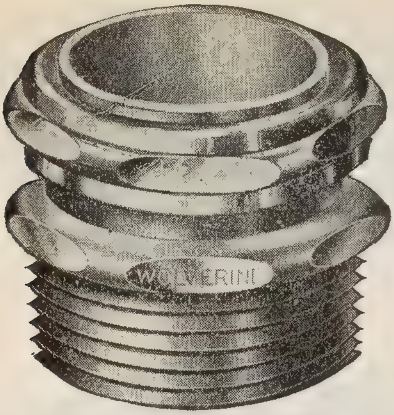


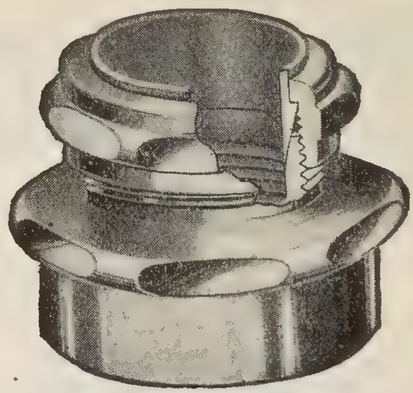


Figs. 7,420 and 7,421.—Wolverine slip joint connections. Fig. 7,420, integral cast pattern; fig. 7,421, trap slip joint for lead waste connecting lead pipe waste to brass tube traps, etc.

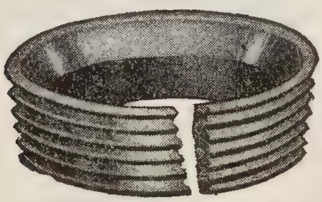


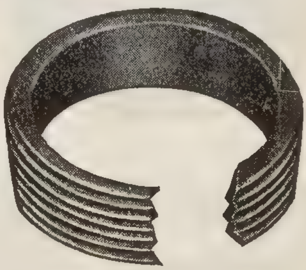
Figs. 7,422 and 7,423.—Wolverine trap slip joints. Fig. 7,422, nickel plated nut; fig. 7,423, rough brass nut. These slip joints are for connecting brass tube waste and vents to wrought pipe. ***Connection consists of,*** nipple, nut, friction ring and rubber S.J. washer.

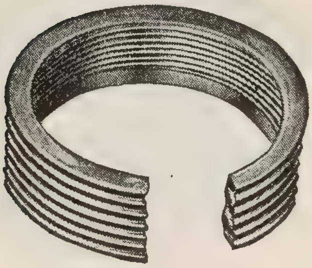


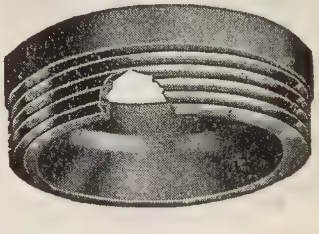


FIGS. 7,424 and 7,425.—Wolverine visible ground joint connections. Fig. 7,424, ***male*** with nickel plated nut; fig. 7,425, ***female*** with nickel plated nut and body. ***These are for*** connecting brass tube waste and vent to wrought pipe, where a brass ground joint is required.

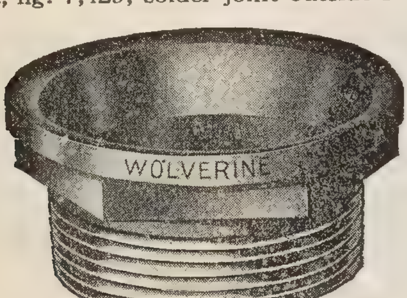




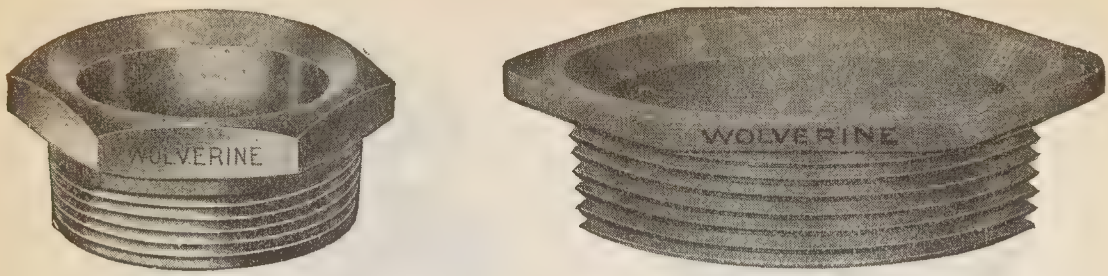




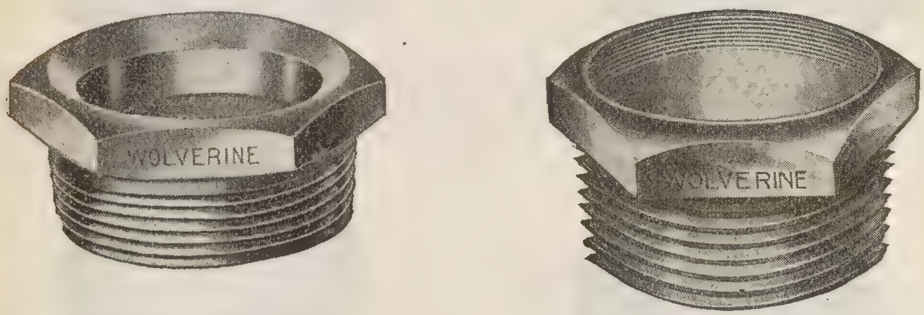
FIGS. 7,426 to 7,429.—Wolverine threaded collars for connecting brass tubing to wrought pipe. Fig. 7,426, solder joint recessed; fig. 7,427, solder joint plain; fig. 7,428, fine thread joint; fig. 7,429, solder joint outside shoulder.



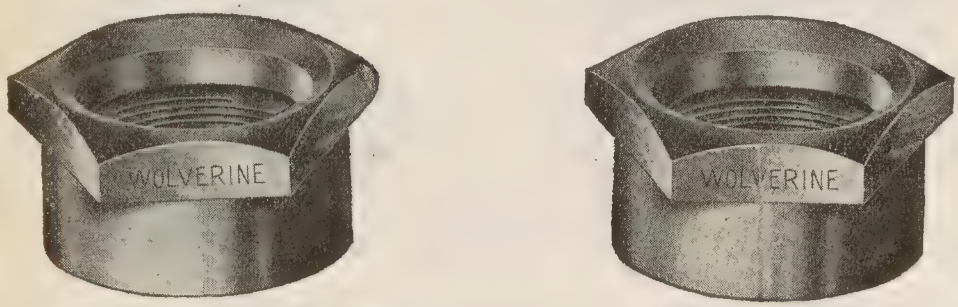
FIGS. 7,430 and 7,431.—Wolverine hexagon trap bushings. Fig. 7,430 bushing for connecting lead pipe to wrought pipe; fig. 7,431, bushing for connecting brass tubing to wrought pipe.



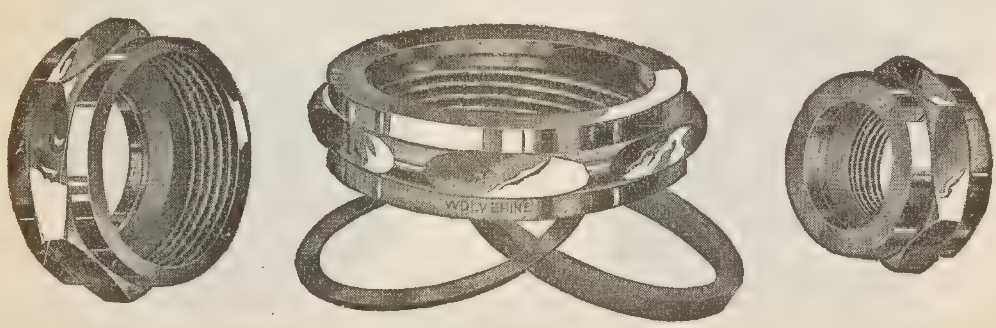
Figs. 7,432 and 7,433.—Wolverine hexagon trap bushings for connecting lead pipe to wrought pipe. Fig. 7,432, solder joint; fig. 7,433, for Durham work.



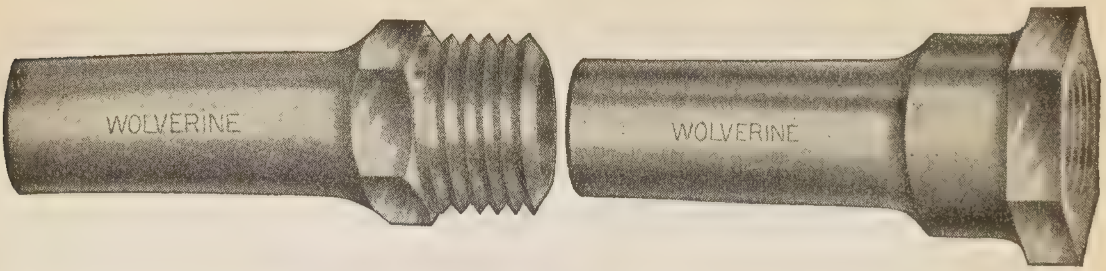
Figs. 7,434 and 7,435.—Wolverine hexagon trap bushings for connecting brass tubing to wrought pipe. Fig. 7,434, solder joint; fig. 7,435, fine thread joint.



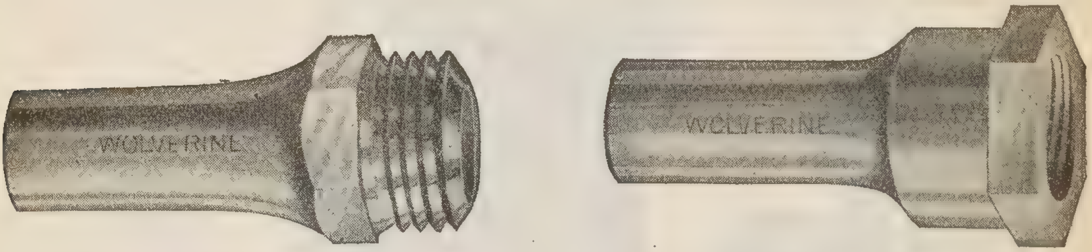
Figs. 7,436 and 7,437.—Wolverine hexagon solder joint female bushings. Fig. 7,436, connects lead pipe to wrought pipe; fig. 7,437, connects brass tubing to wrought pipe.



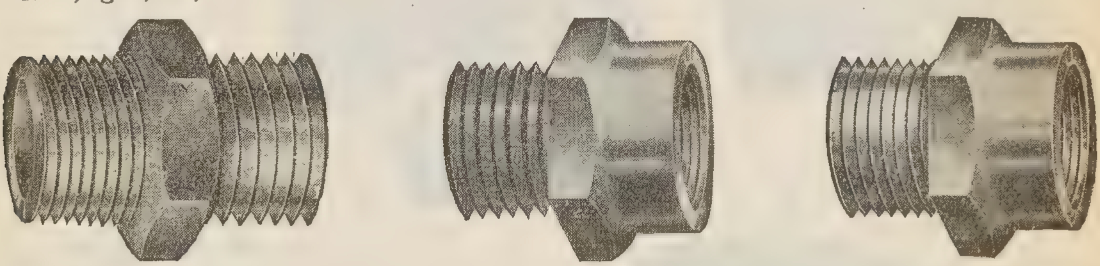
Figs. 7,438 to 7,440.—Wolverine slip joint nuts with friction ring and slip joint washer.



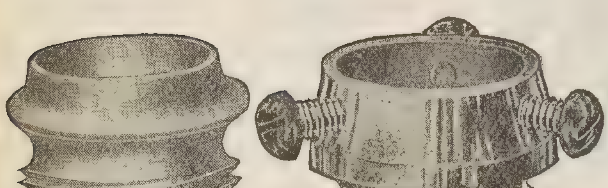
FIGS. 7,441 and 7,442.—Wolverine soldering nipples. Fig. 7,441, male; fig. 7,442, female.

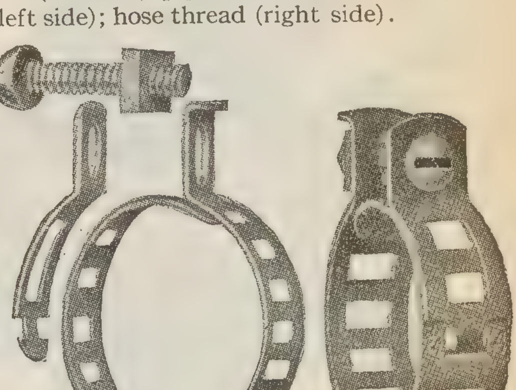


FIGS. 7,443 and 7,444.—Wolverine revent soldering nipples, standard pattern. Fig. 7,443, male; fig. 7,444, female.



FIGS. 7,445 to 7,447.—Wolverine hose nipples. Fig. 7,445, male; hose thread (left side) pipe thread (right side); fig. 7,446, female, hose thread (left side) pipe thread (right side); fig. 7,447, female with reversed threads, pipe thread (left side); hose thread (right side).



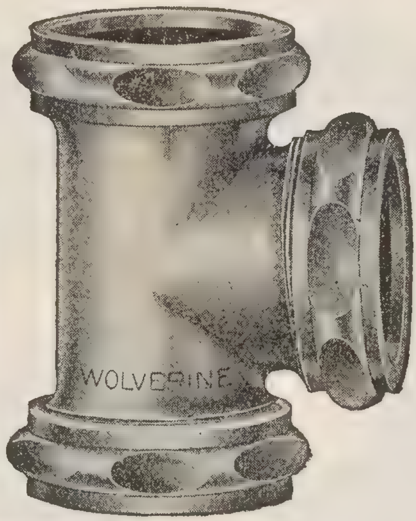


FIGS. 7,448 and 7,449.—Wolverine bibb ends. Fig. 7,448, for soldering; fig. 7,449, for screw fastening.

FIGS. 7,450 to 7,453.—Wolverine "Fitsall" hose clamps. Figs. 7,450 to 7,452, clamp disassembled; fig. 7,453, clamp assembled.

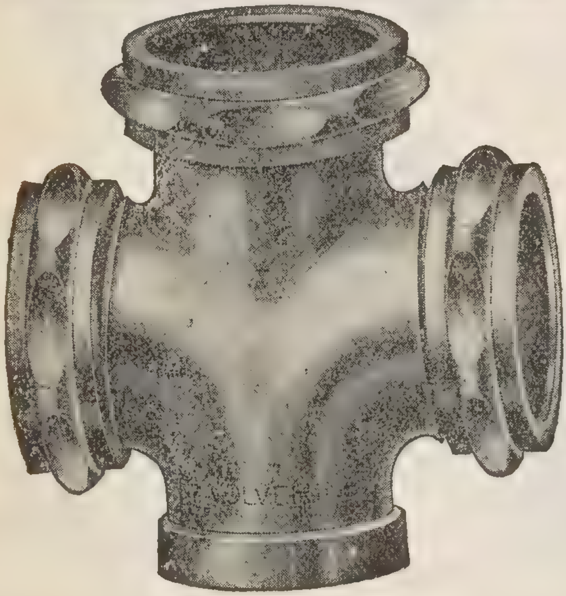
lighter weight and threaded with the fine threads as given in the table. Figs. 7,394 to 7,399 show the appearance of these fittings.

Slip Joint Fine Thread Fittings.—Considerable use is made of this class of fine thread fittings because of the ease in making up a line obtained with the slip joint.



The slip joint is simply *a form of stuffing box through which the tubing passes to form a tight joint.*

C



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The flexibility of make up and construction of the slip joint is shown in fig. 7,400. Here, in making up the joint the tube inserted in the coupling at the slip joint end may be placed either in position L, or position F, (dotted lines) or in any position within the limit of the coupling, that is between the end of the other pipe or up to the rubber washer. The general appearance of slip joint fittings is shown in figs. 7,454 to 7,456.

FIGS. 7,454 to 7,456.—Slip joint fittings. 3. **A,** sanitary tee, one end of run and branch threaded; **B,** sanitary tee, all slip joint; **C,** sanitary cross all slip joint.

CHAPTER 119

Fixtures

In any plumbing installation there are numerous familiar devices called *fixtures*. The fixtures ordinarily installed are:

1. In the bath room.
   - *a.* Lavatory.
   - *b.* Bath tub.
   - *c.* Shower bath.
   - *d.* Urinal.
   - *e.* Closet.
   - *f.* Bidet.
2. In the kitchen.
   - *a.* Hot water tank.
   - *b.* Sink.
   - *c.* Laundry tub.

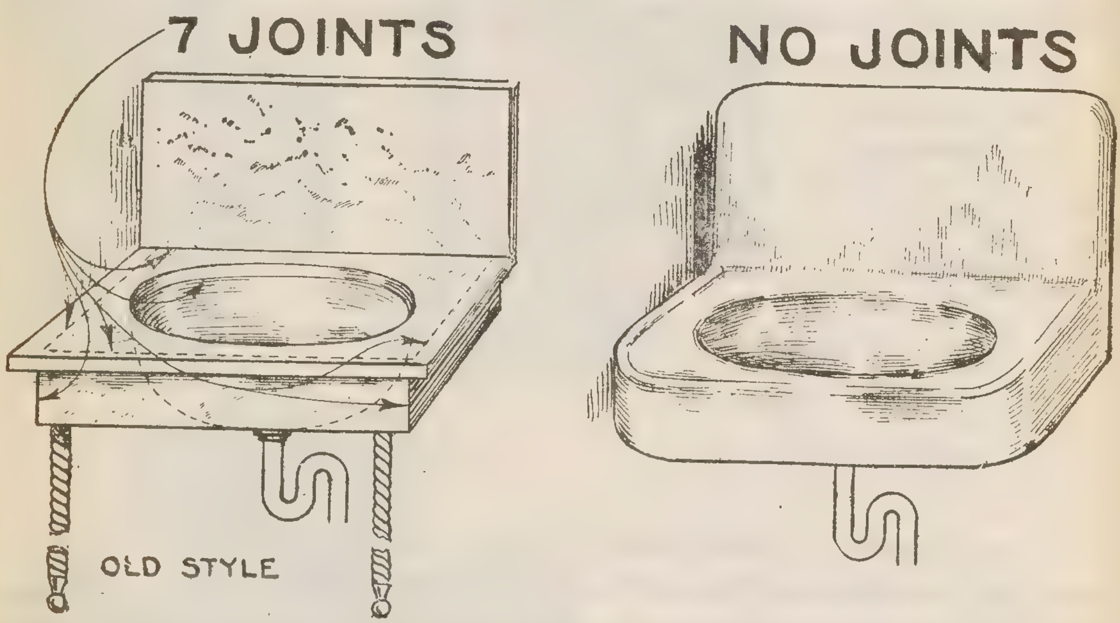
The plumber is concerned more especially with how to connect up the fixtures than with their construction, and in making the necessary water supply, waste and soil connections, he must be well informed as to the construction and working of the various accessories required. These are presented at great length in the preceding chapter and a thorough knowledge of all the principles of operation as therein presented will be found very helpful.

1. Bath Room Fixtures

Lavatory.—By definition the term lavatory is *an apartment*

for washing, but for some unaccountable reason it is applied by the trade to the wash basin forming one of the bath room fixtures.

Formerly lavatories were made in several pieces consisting of a bowl attached to the underside of a marble slab resting on an *apron,* and having another piece of marble forming the back. Evidently the joint in this construction presented places for the collection of filth and were therefore unsanitary. The modern lavatory in which the bowl, slab and back are cast in one piece is both sanitary and economical in the labor of in-

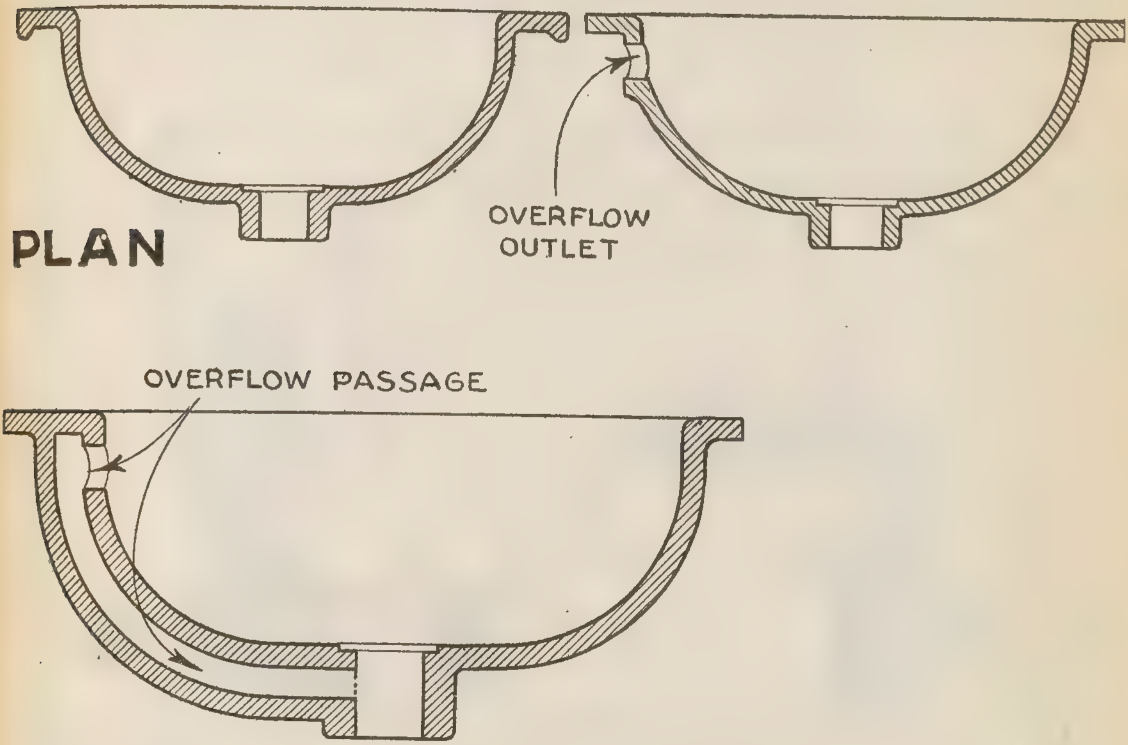


FIGS. 7,457 and 7,458.—Old style marble and modern porcelain or enameled iron lavatories; note the absence of joints in the latter, and also the absence of legs which permits sweeping the floor with greater ease.

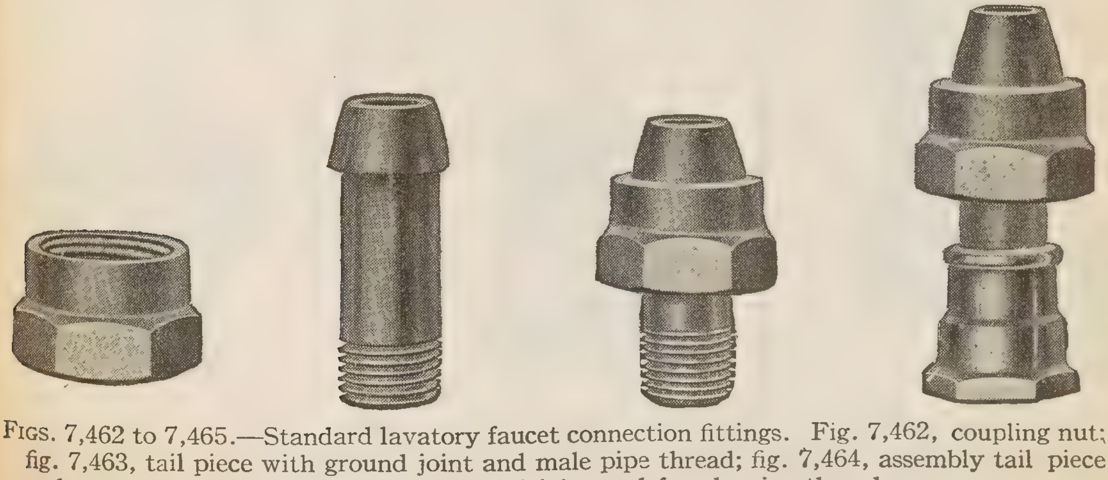
stalling as there are no joints to be cemented. These differences are plainly shown in figs. 7,457 and 7,458. The bowls, whether of the old or new style lavatory are arranged:

1. Without waste passage, or ports.
2. With waste and overflow outlets.
3. With integral waste passage. These three types of bowl are shown in figs. 7,459 to 7,461.

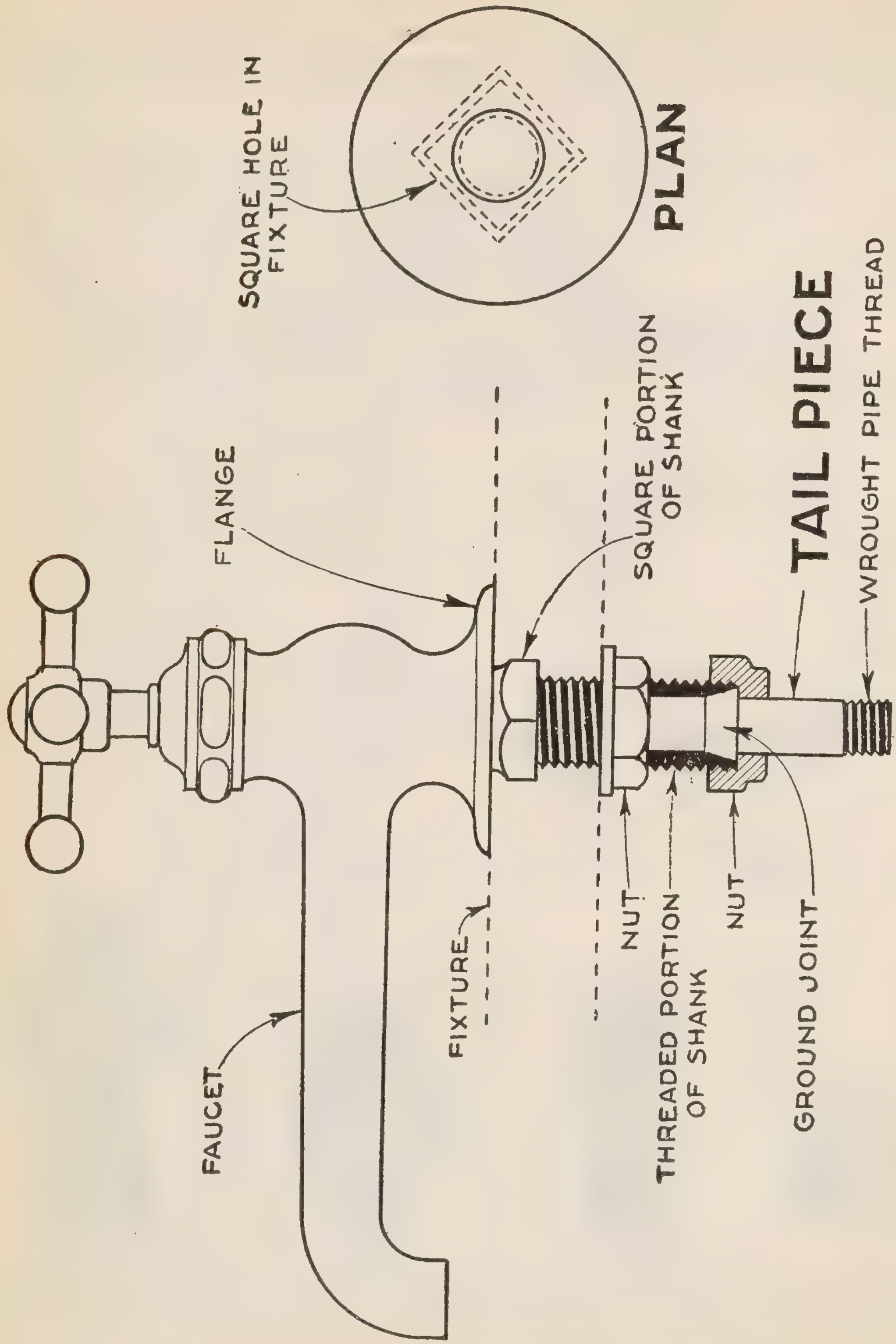
Lavatory Supply Connections.—The hot and cold water faucets are usually arranged to pass through the fixture; the faucets have an ornamental flange as a base.



Figs. 7,459 to 7,461.—Various types of lavatory bowl. Fig. 7,459, plain; fig. 7,460, with overflow outlet; fig. 7,461, with one passage cast integral with bowl.



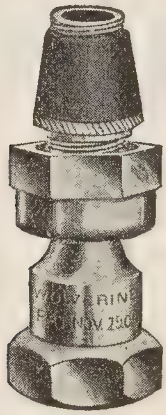
Figs. 7,462 to 7,465.—Standard lavatory faucet connection fittings. Fig. 7,462, coupling nut; fig. 7,463, tail piece with ground joint and male pipe thread; fig. 7,464, assembly tail piece and nut; fig. 7,465, tail piece with ground joint and female pipe thread.

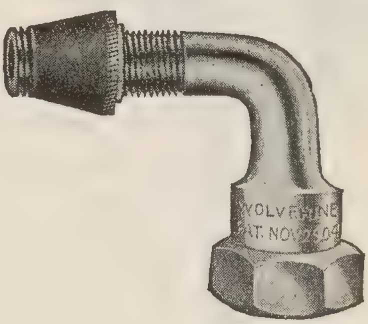


FIGS. 7,466 and 7,467.—Lavatory faucet connections. Fig. 7,466, sectional view; fig. 7,467, plan of base.

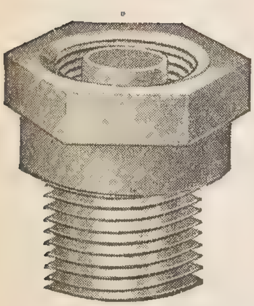
Figs. 7,466 and 7,467 show the method of securing faucets to the fixture and the supply connection as shown, the flange of the faucet rests on the fixture and passes through a square hole, part of the shank being of square section; this is to prevent the faucet turning while tightening the nut which holds the faucet in place. The lower or threaded portion of the shank forms with a nut, part of a union of which the *tail piece* forms the other part.

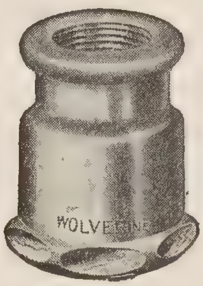
The object of the tail piece besides forming a tight joint is to provide a means of continuing the supply line using either plumbers' fine thread or wrought pipe thread.

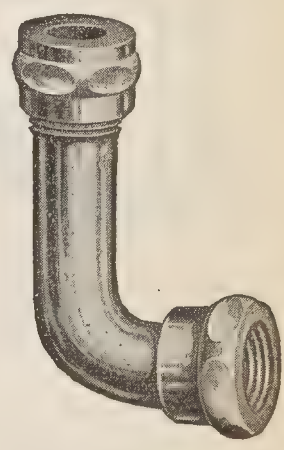




FIGS. 7,468 and 7,469.—Wolverine lavatory faucet connections. Fig. 7,468, straight tail piece; fig. 7,469, 90° elbow tail piece with soft metallic adjustable cone joint and coupling nut.

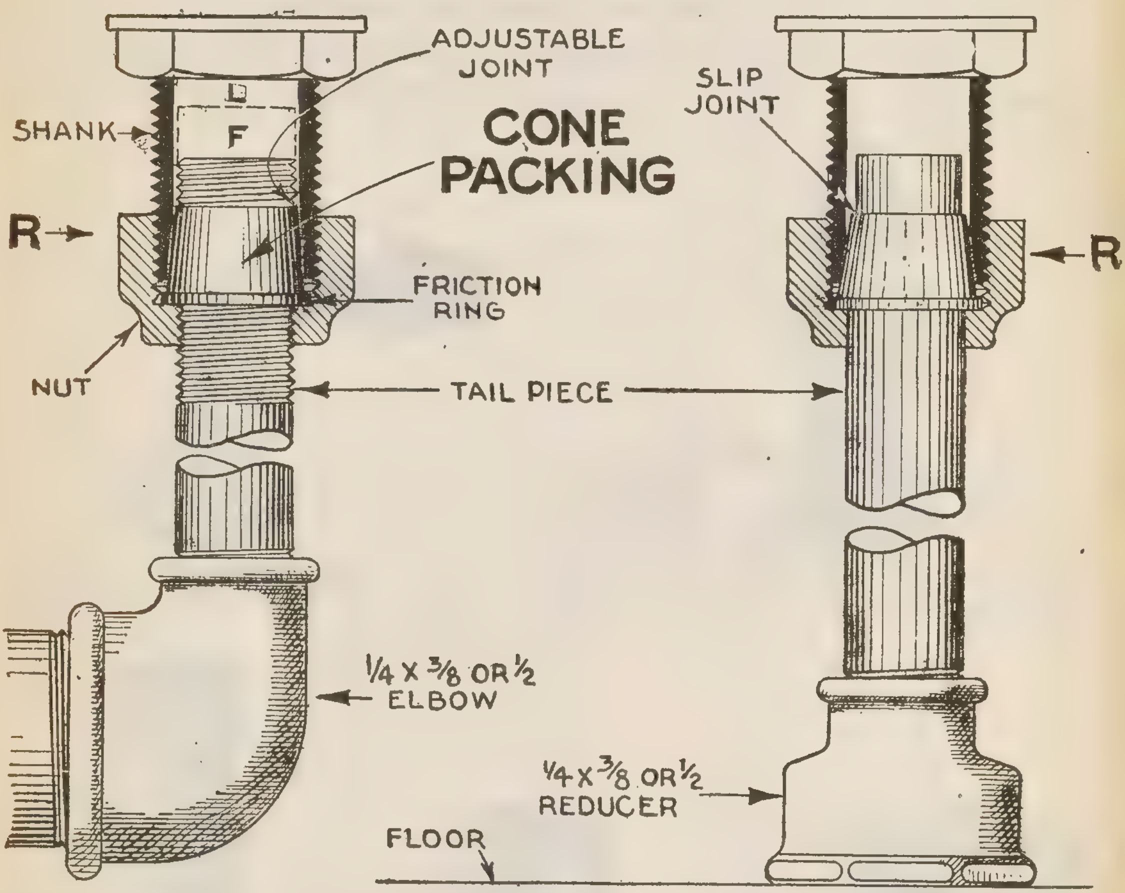






FIGS. 7,470 to 7,472.—Wolverine lavatory faucet connections. Fig. 7,470, shank reducer to screw on National Standard basin cock shank and to receive the coupling of old style cocks fig. 7,471, supply reducer for floor connection; fig. 7,472, Pacific Coast slip joint elbow tapped for; ½ in. pipe thread, slip joint for $\frac{7}{16}$ or ½ in. *o. d.* (outside diameter) tube.

The illustration shows a ground joint connection with the shank and a male wrought pipe thread on the other end of the tail piece. As there is a great variety of tail pieces obtainable any kind of a connection can be made to suit conditions. By the use of flexible composition, or soft metallic cone packings and friction rings adjustable and slip joints are obtained between the tail piece and faucet shank respectively as shown in figs. 7,473 and 7,474. In making up the connection, with the adjustable joint



FIGS. 7,473 and 7,474.—Tail pieces with cone packing. Fig. 7,473, adjustable joint with soft metallic packing and supply elbow for wall connection; fig. 7,474, slip joint with flexible composition cone packing and reducer for floor connection.

(fig. 7,473) the tail piece is inserted in the faucet shank and its lower end screwed into the elbow; this will lower the upper end of the tail piece from some position as L, to F. The cone packing is now brought into contact with the faucet shank by turning the friction ring and the joint made tight by screwing up nut R.

Similarly in making up the connection with the slip joint (fig. 7,474), the flexible composition packing backed with a metal ring is simply pushed into position against the shank bearing and the nut R, tightened.

Note that the end of the tail piece is threaded for the adjustable joint (fig. 7,467) and left plain for the slip joint (fig. 7,474). This adjustable feature renders the work of making up the connections easy, as it is not necessary to cut the tail piece to an exact length.

FIGS. 7,475 to 7,478.—Wolverine cone packings for lavatory and bath connections. Figs. 7,475 and 7,476, flexible composition, basin size 13⁄32 in. *i. d.* (inside diameter), bath size 21⁄32 *i. d.*; figs. 7,477 and 7,478, soft metallic, basin size 7⁄16 in. 27 threads, bath size 11⁄16 in. 20 threads.

Figs. 7,466 and 7,468 illustrate a principle employed in tail piece joints and as before mentioned there are numerous forms of tail pieces as illustrated in the accompanying cuts.

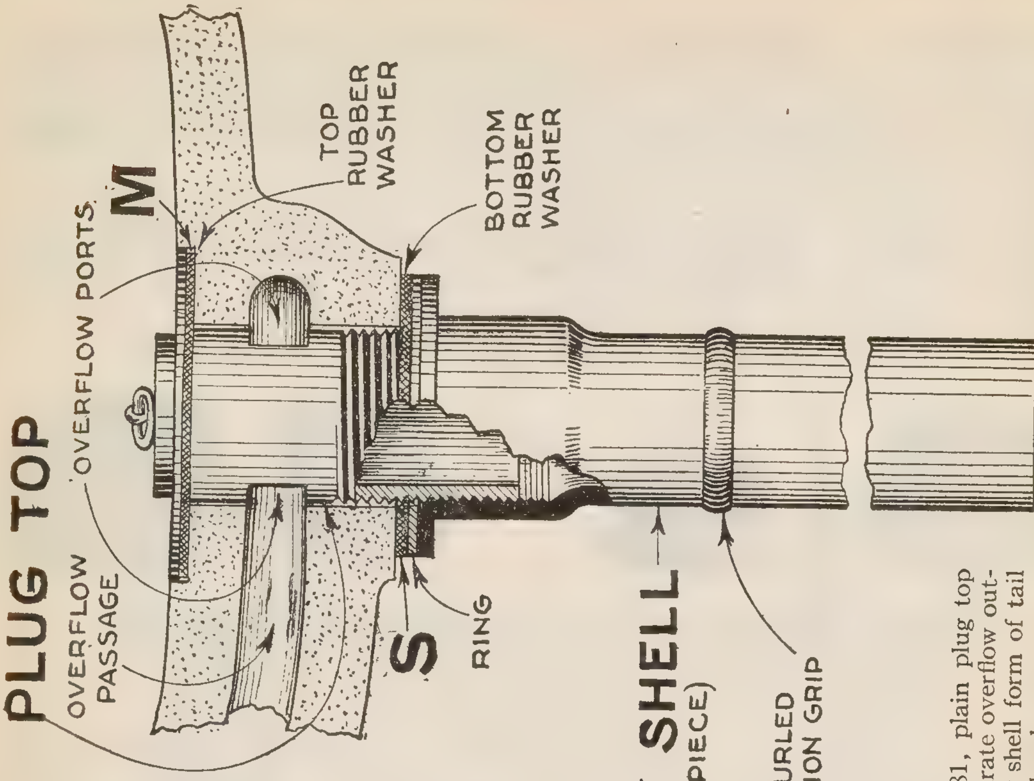
FIGS. 7,479 and 7,480.—Wolverine threaded brass friction rings for cone packings. Fig 7,479, basin size 7⁄16 ×27; fig. 7,480, bath size 11⁄16 ×20.

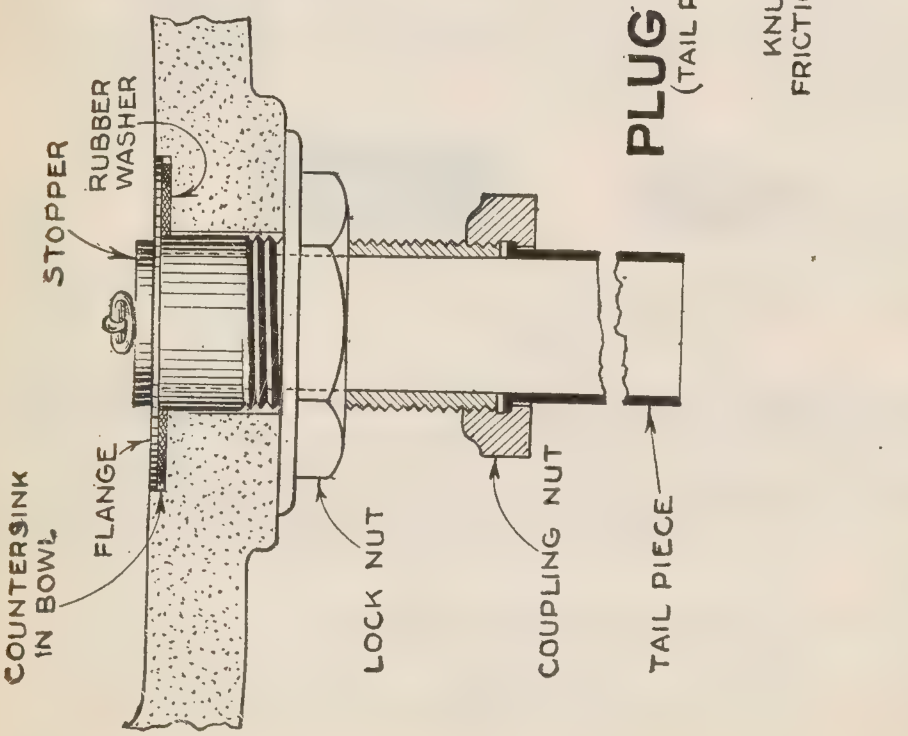
Lavatory Waste Connection.—The waste pipe is connected to the lavatory bowl in various ways, the connecting fitting being known as a plug top. It consists essentially of a short length of pipe having a flange on one end and threaded at the other end.

There are two general classes of plug top,

1. plain.

For bowls with separate overflow outlet.





FIGS. 7,481 and 7,482.—Plug tops and connections. Fig. 7,481, plain plug top with lock nut and coupling nut showing connection with separate overflow outlet bowl and tail piece; fig. 7,482, ported plug top with plug shell form of tail piece showing connection with combined waste and overflow bowl.

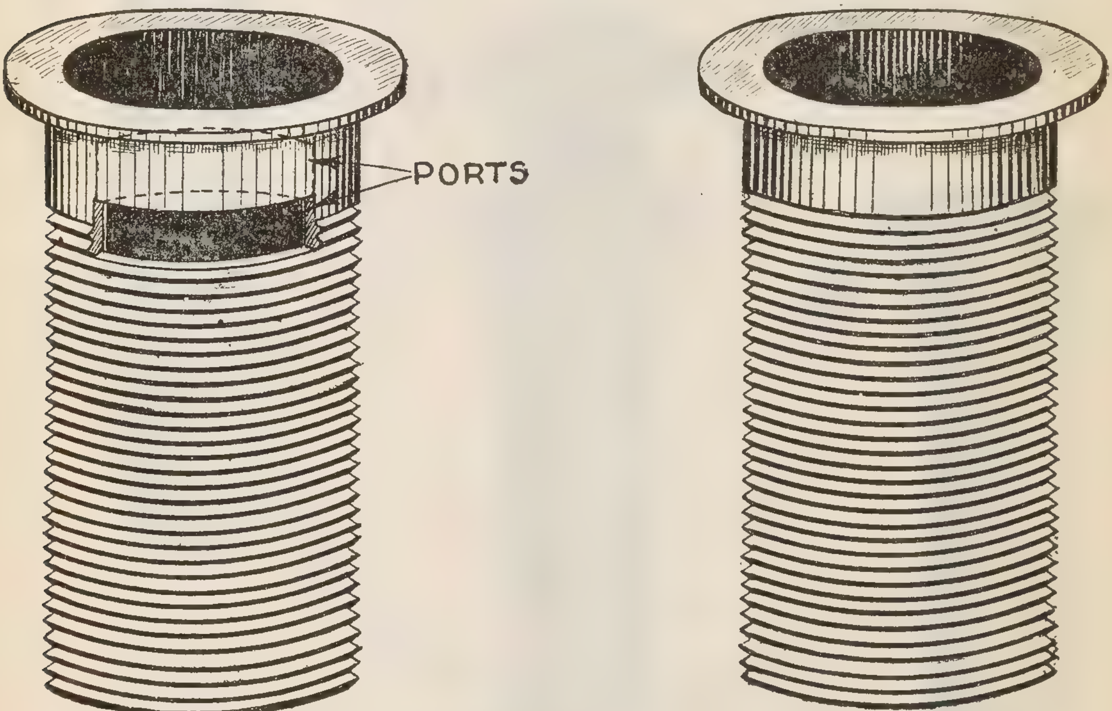
2. Ported.
   For bowls having combined waste and overflow outlet.

These two basic types are shown in figs. 7,483 and 7,484.

The methods of connecting these to the bowl are shown in figs. 7,481 and 7,482. The plain plug top is shown in fig. 7,481.

With this type a tight joint is secured by placing a rubber washer under the flange and tightening the lock nut. A countersink in the bowl brings the top of the flange flush with the bowl as shown.

A tail piece is shown connected to the threaded end of the plug top by a coupling nut. The use of the tail piece evidently permits a slip joint connection with the trap.

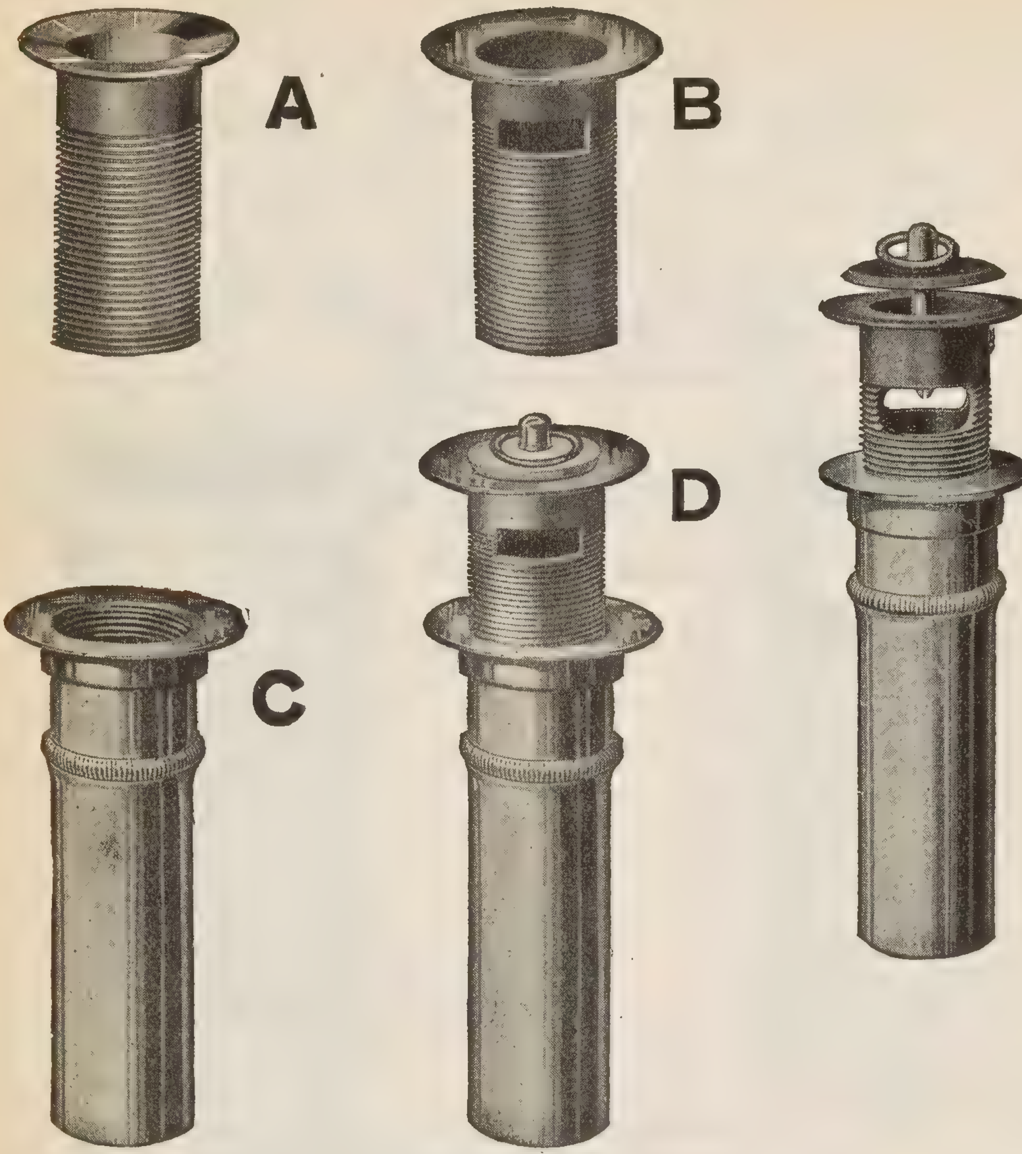


FIGS. 7,483 and 7,484.—Plain and ported lavatory plug tops or waste connection fitting.

Where the bowl has a combined waste and overflow outlet as in fig. 7,482, evidently two rubber washers M and S, are required to secure a tight joint and bring flange flush with bowl unless the flange be thick enough to accomplish this.

A different kind of a tail piece, known as a plug shell is here shown.

In some cases where it is desired to make a close connection a special elbow is used as in fig. 7,536.



FIGS. 7,485 to 7,489.—Wolverine lavatory waste connections. **A,** plain plug top; **B,** ported plug top; **C,** plug shell; **D,** assembly ported plug top, plug shell and stopper; **E,** assembly, ported plug top, with attached stopper, and plug shell.

NOTE.—In order that plumbing fixtures should give the service and satisfaction expected of them, the brass fittings should be of a quality equal to the fixtures themselves. Obviously the maker of the fixtures should make the brass goods, for only by doing so can complete harmony be obtained. Accordingly, when this practice is followed, one manufacturer is responsible, otherwise responsibility is divided. Another reason for recommending this procedure is that on the higher quality fixtures, the brass goods are fitted to each fixture at the factory, thus insuring against trouble or possible readjustments when installing.

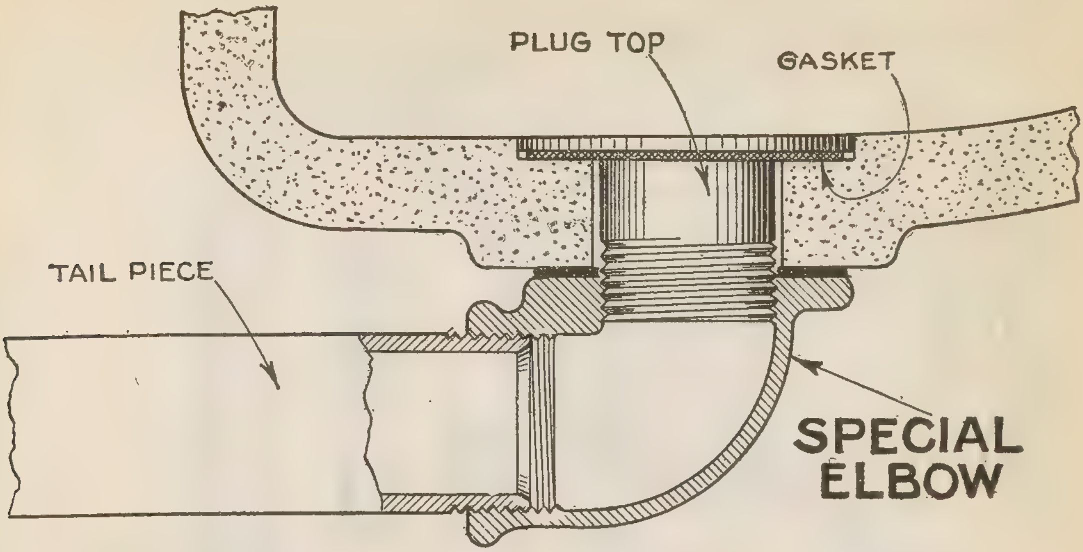


FIG. 7,490.—Plug top and special elbow connection for high up horizontal tail piece.

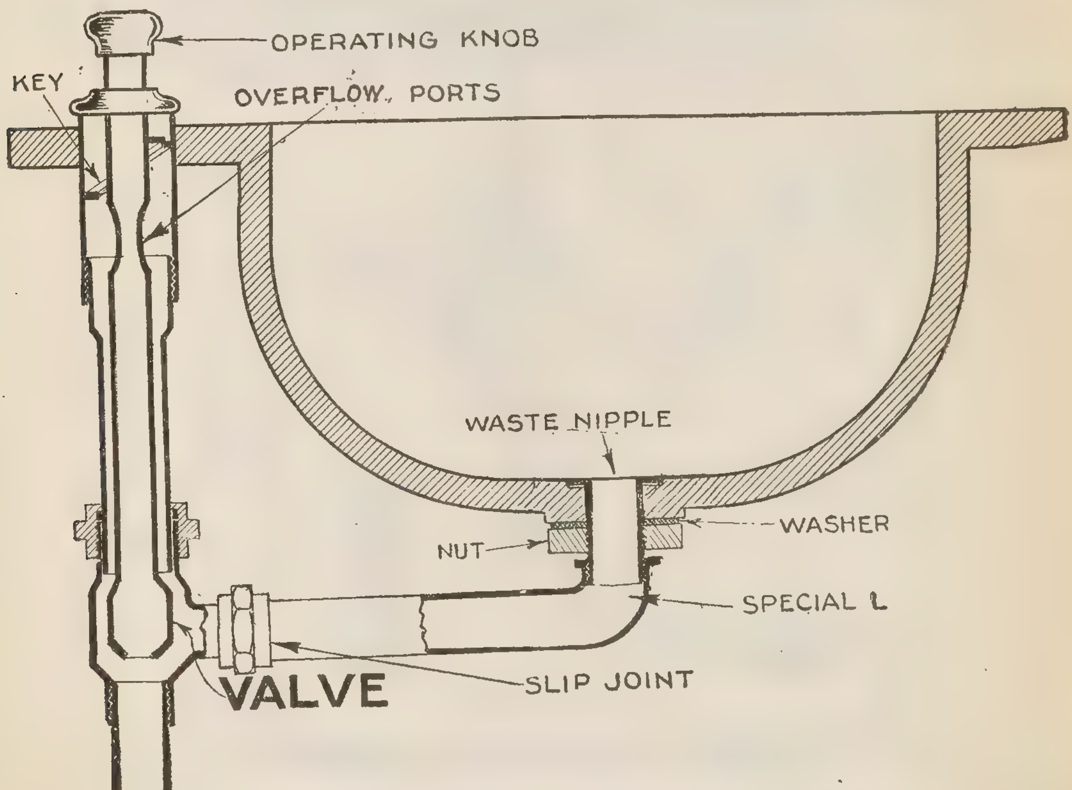
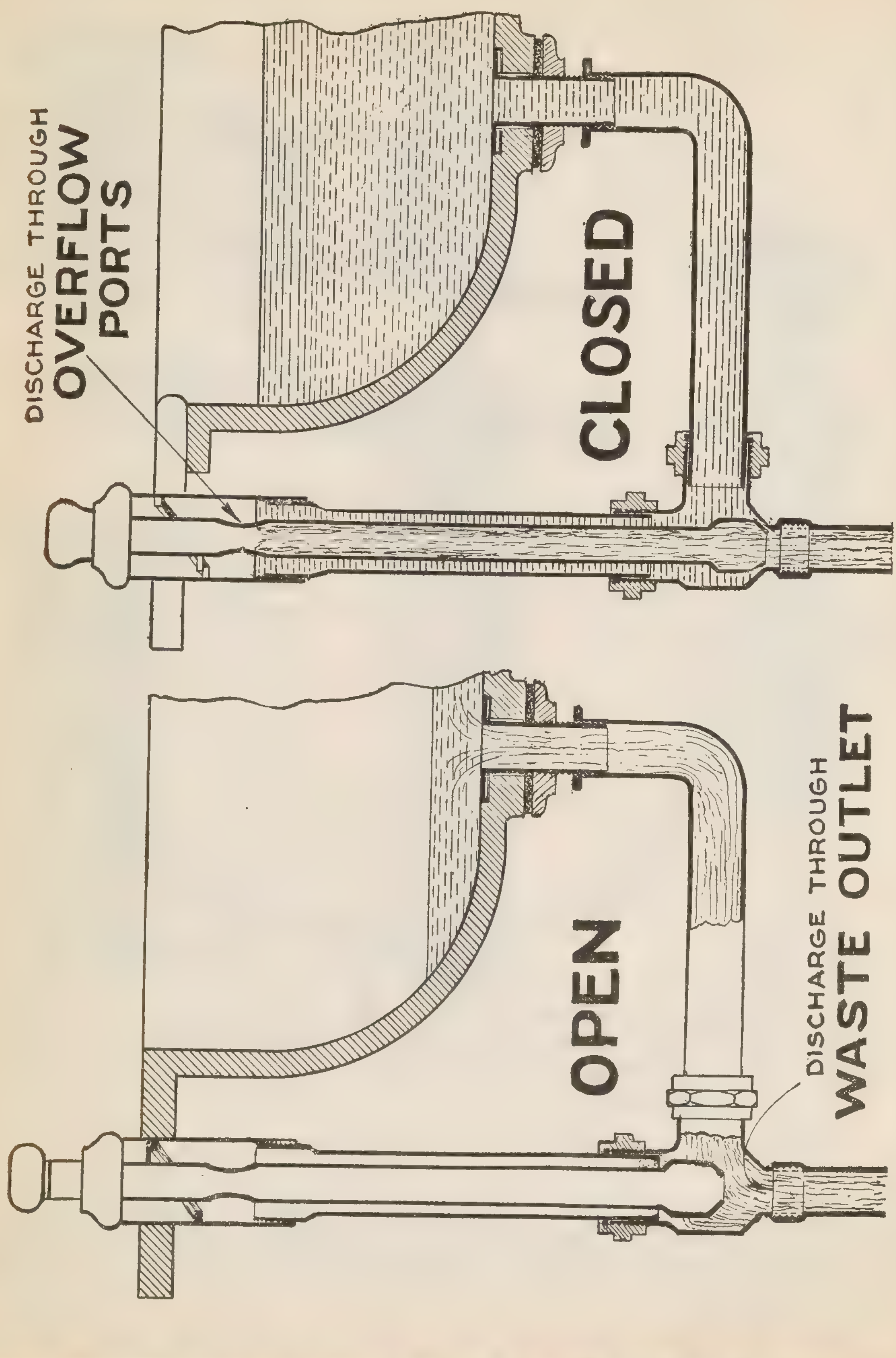


FIG. 7,491.—Connection for bowl without waste passage or ports. ***Provision*** is made for overflow in the construction of the hollow plug valve by an extension or sleeve having overflow ports in the upper end and fitting in a larger pipe, as shown. The valve is opened by raising the knob, and secured in position by slightly turning it so that the key will enter a slot cut in the sleeve.



FIGS. 7,492 and 7,493.—Waste and overflow lavatory valve in open and closed position showing respectively discharge through waste outlet and overflow through overflow ports.

The method of connecting a bowl with waste and overflow outlets is shown in fig. 7,494.

Here use is made of an adjustable slip joint waste and overflow combination of fittings, of which there is a great variety of designs. The type

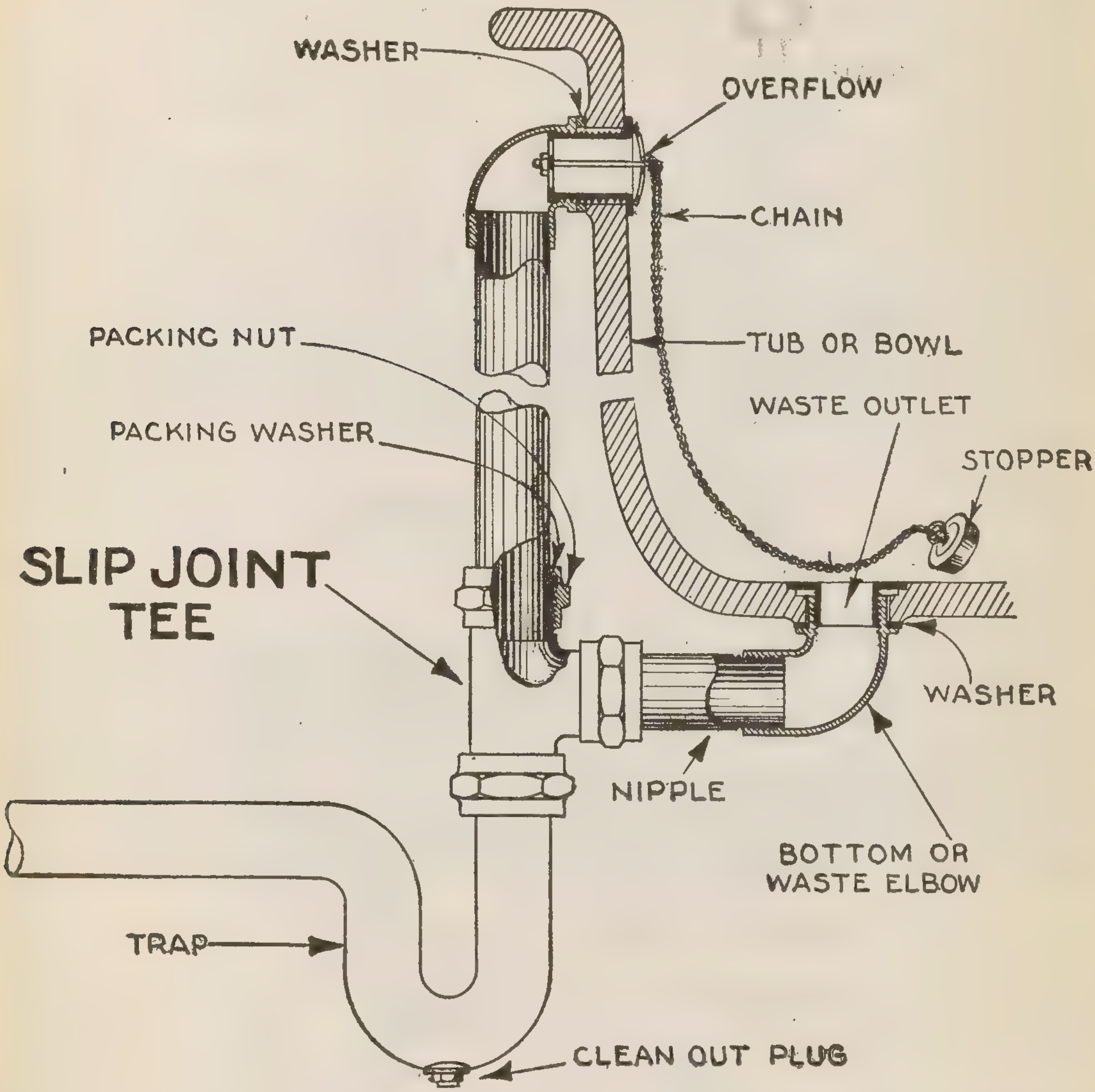


FIG. 7,494.—Connections for bowl having waste and overflow outlets consisting of plumbers five thread fitting, with slip joint sanitary tee and trap nickel plated.

illustrated in fig. 7,494 consists of the overflow and waste connections branching from a sanitary slip joint tee, having a trap connected at the lower end. There are plumber's fine thread fittings, the tee being slip joint

and as they are nickel plated and polished the assembly presents a fine appearance.

Fig. 7,495 shows a bowl with internal overflow passage fitted with a type of waste valve extensively used and known as a "pop up" waste because in

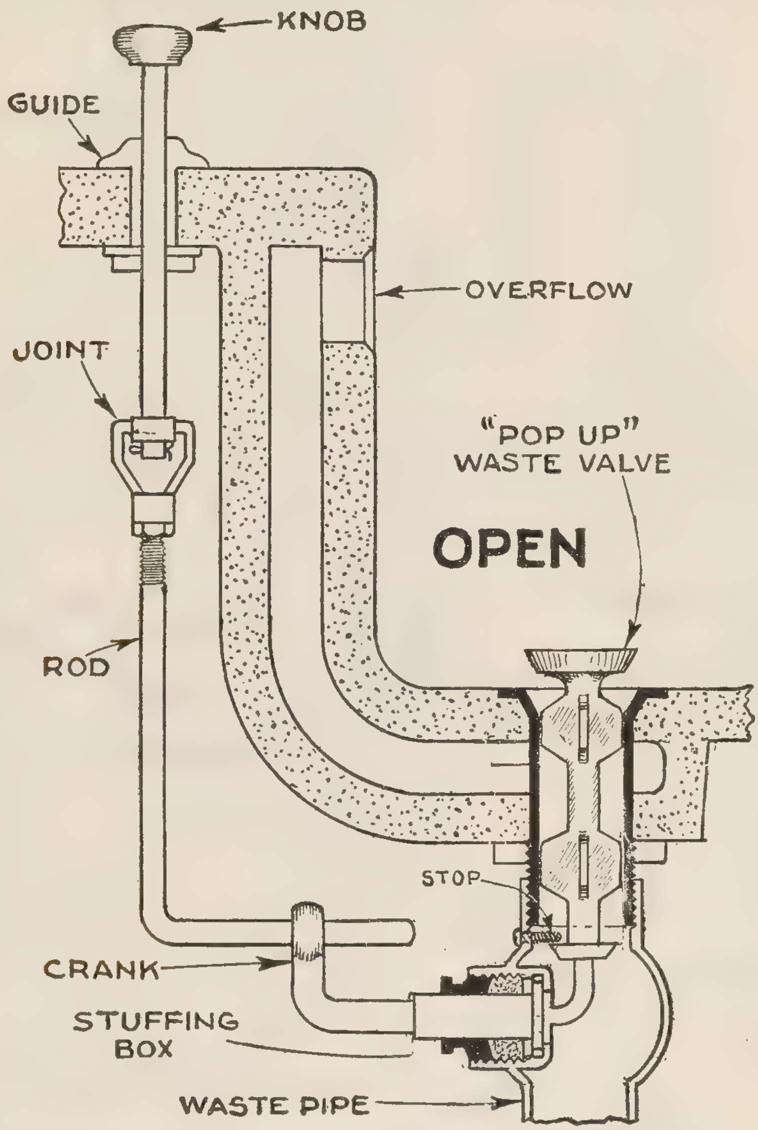


FIG. 7,495.—Connection for bowl having integral waste passage and fitted with "pop up" type waste. ***In opening*** the valve, the knob is pulled up or pushed down depending upon the type of transmission employed causing the waste valve to rise or "pop up." The valve is here shown in open position.

operation when the knob is pulled, the valve "pops up" in opening. The illustration illustrates the connections and needs no further explanation.

Bath Tub.—Most types of bath are made in several sizes ranging from 4 to 6 ft. The so called bath tubs as put in some apartment houses necessitates a stretch of the imagination to consider them as bath tubs, being not much more than large lavatories in which a bath may be taken on the installment plan. The prevailing construction of bath tubs is of porcelain enameled, the tub with its rim, legs or pedestal being made in

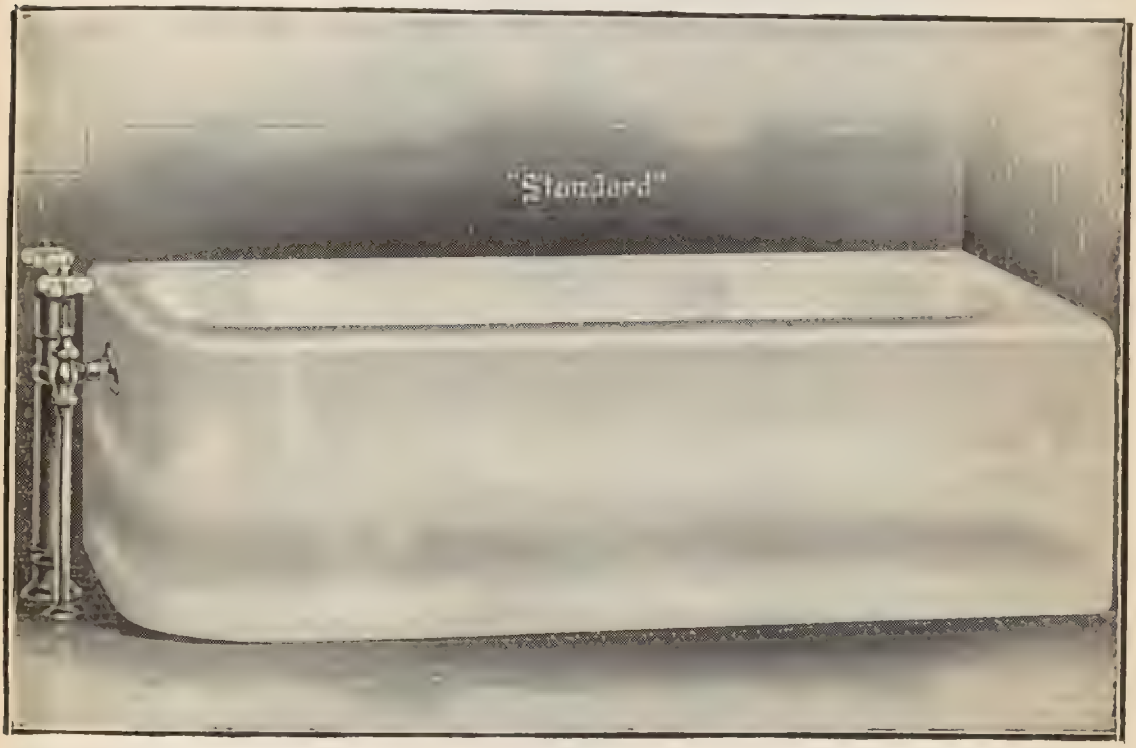
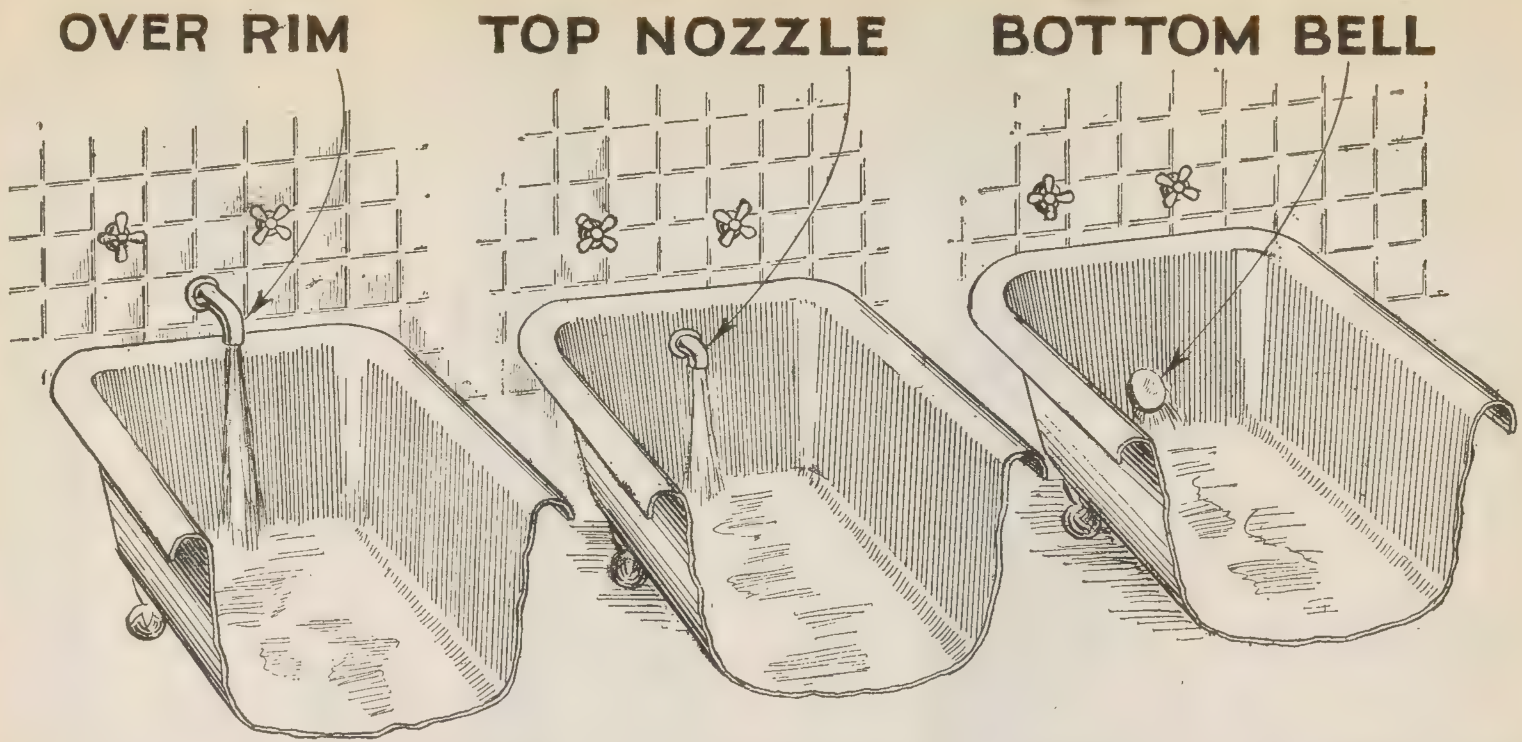


FIG. 7,496.—Standard "Pembroke" one piece built in enameled bath tub with left outlet.

one piece. How bath tubs are made is not of so much importance to the plumber as is how the connections are made.

With the approved slip joint connecting fittings now obtainable in a great multiplicity of designs to meet all conditions of installation, the job of connecting up a bath tub should present no difficulty.

The fittings required usually come with the tub and are therefore of proper size to connect with the outlets.



FIGS. 7,497 to 7,499.—Three methods of delivering the water supply to tub. Fig. 7,497, over rim; fig. 7,498, top nozzle; fig. 7,499, bottom nozzle.

NOTE.—This is an era of unusual achievement in the development of home furnishings and equipment. In keeping with the progress exemplified by the adoption of better lighting ideas, improved heating systems, vacuum cleaners, electrical conveniences and numerous other household utilities, bath tubs have progressed from just "bath tubs" to built-in baths. The development of bath tubs has developed the enameling art to the point where there can be produced, as a commercial success, a *one piece* enameled all over bath. What was wanted was a bath that could be built into the floor and walls so that places which gather dust, dirt and moisture (causing housekeepers so much extra work) would no longer exist.

For any particular tub the roughing in measurements sheet will indicate the location of the holes for the connections and for which the design of the fittings must correspond.

Bath Tub Supply Connections.—Bath tubs are regularly

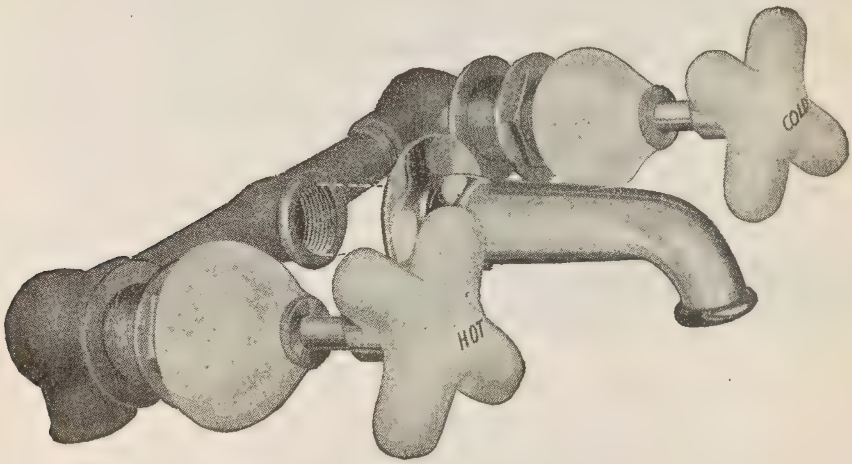


FIG. 7,500.—Wolverine concealed over rim water supply fittings, ***comprising***, hot and cold angle cocks, long tee and nozzle.

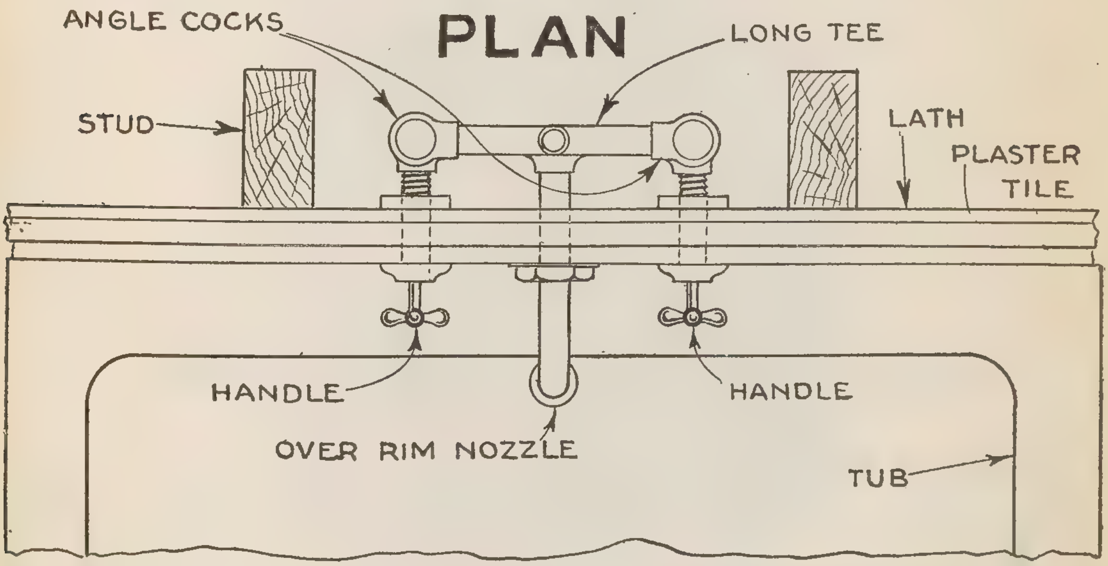


FIG. 7,501.—Concealed over rim water supply connections showing angle cocks, with lock nuts and bonnets, long tee and over rim nozzle.

made for several methods of delivering the water, known as,

1. Over rim supply.
2. Top nozzle supply.

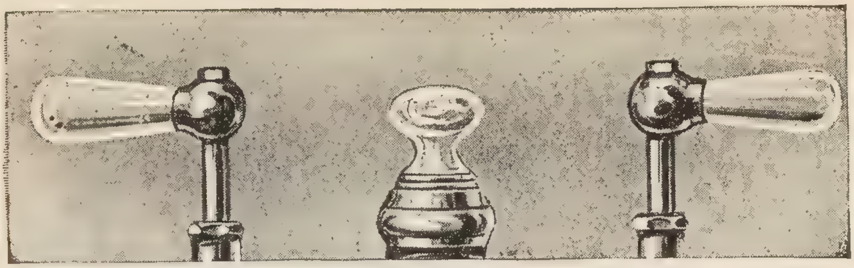


FIG. 7,502.—Speakman lever handles for ***exposed*** bath supply and waste connections.

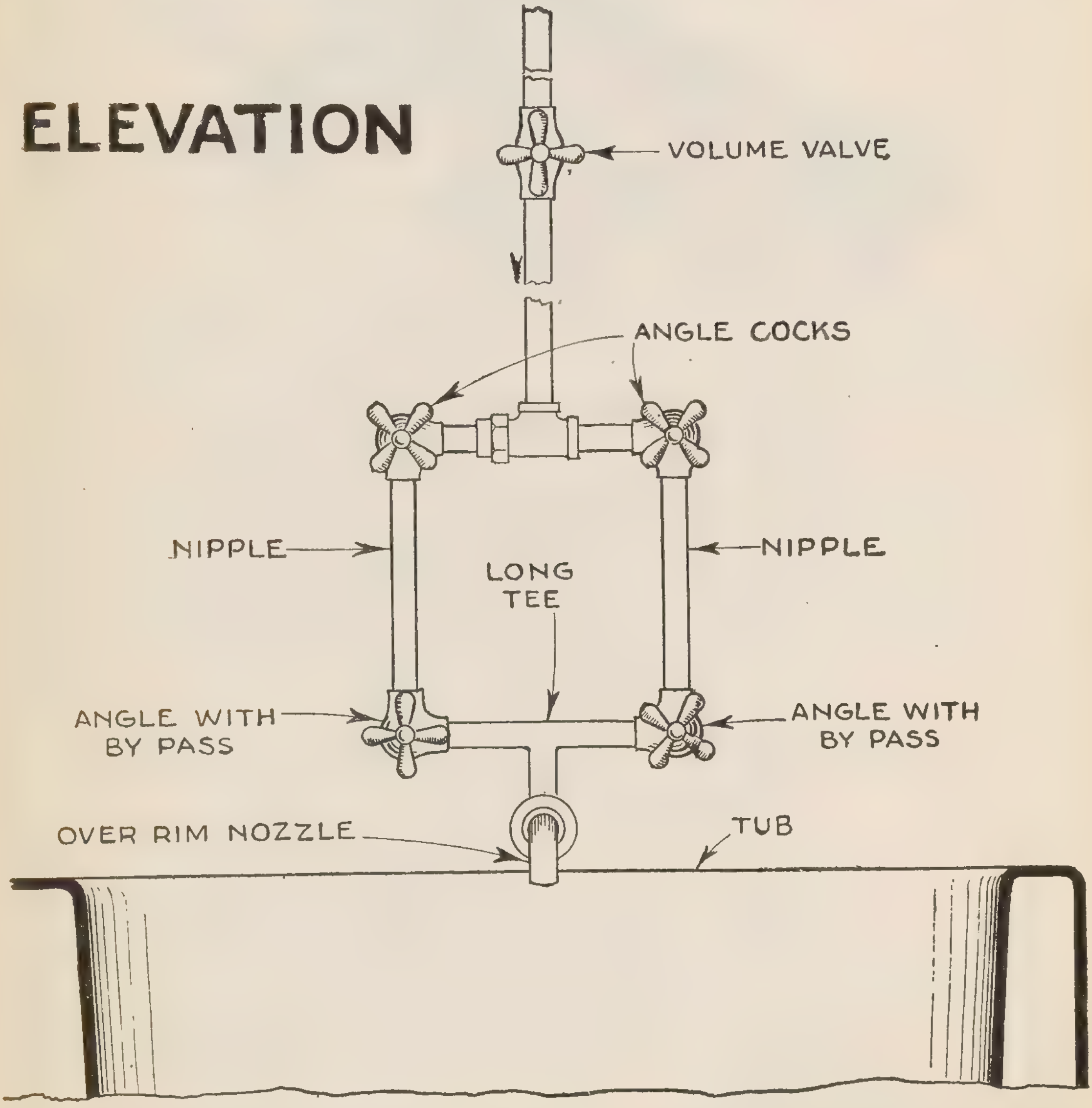


FIG. 7,503.—Concealed over rim water supply connections for tub supply and for shower supply with volume control to shower (five valve combination).

3. Bottom bell supply.

These various methods of delivering the water to the tub are shown in figs. 7,497 to 7,499. For the over rim supply, evidently no holes through the tub are required, the valves (except the handles) being placed behind the wall.

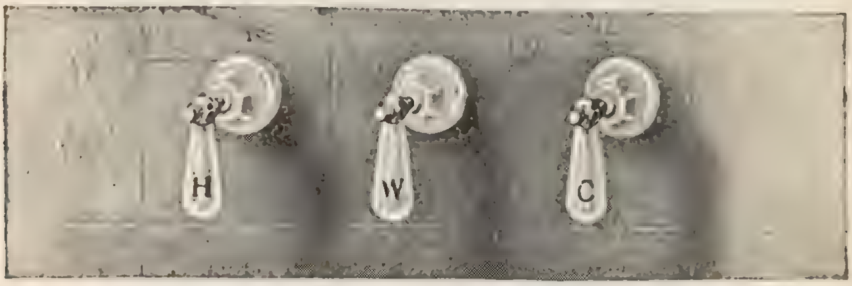


FIG. 7,505.—Speakman lever handles for ***concealed*** bath supply and waste connections.

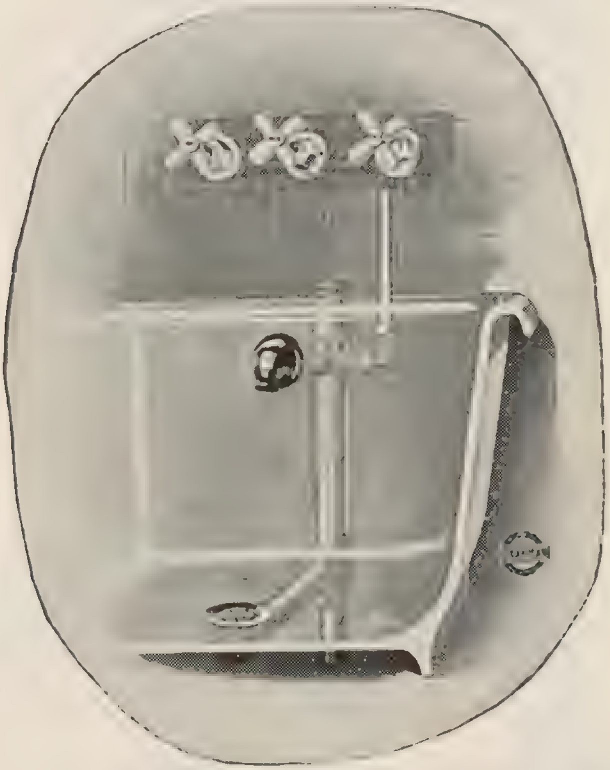
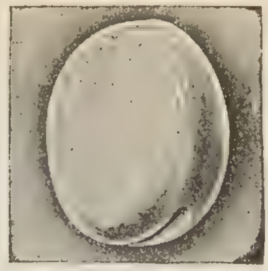


FIG. 7,504.—Speakman Deshler concealed bath supply and waste connections. $1\frac{1}{2}$ in. size with high seat by pass pattern valves having solid china cross arm handles and china escutcheons, top nozzle supply and 2 in. standing waste for enameled iron tub having bottom outlet. Piping between valves and nozzle is galvanized iron.



FIGS. 7,507 and 7,508.—Speakman "Brute" pattern top nozzle and bottom china bell.

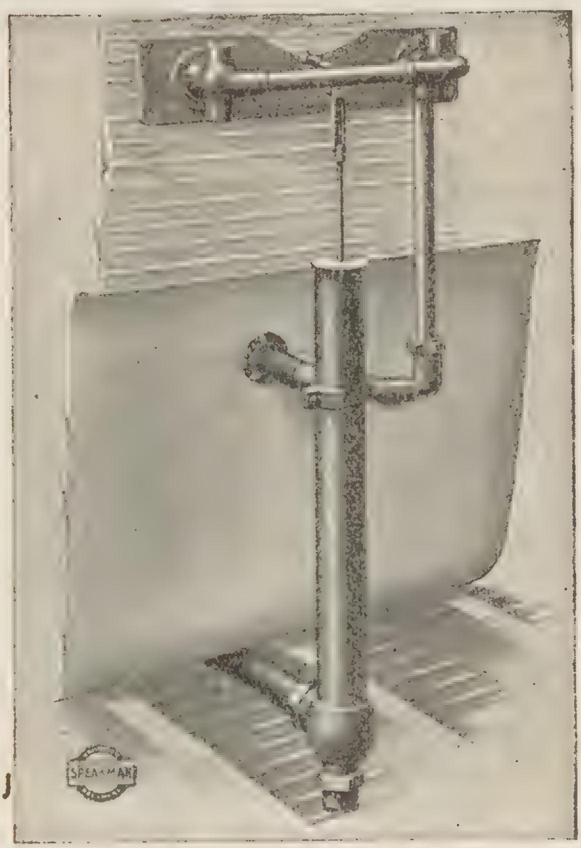


FIG. 7,506.—Back view of Speakman Deshler concealed bath supply and waste connections. The valves are by pass pattern, thus permitting connections to be made either from above or below, the other end of the valves being plugged. The by pass valves are also convenient for shower connections. The thread on the body of valves for slip nut is wrought pipe size, permitting that method of connection if desired.

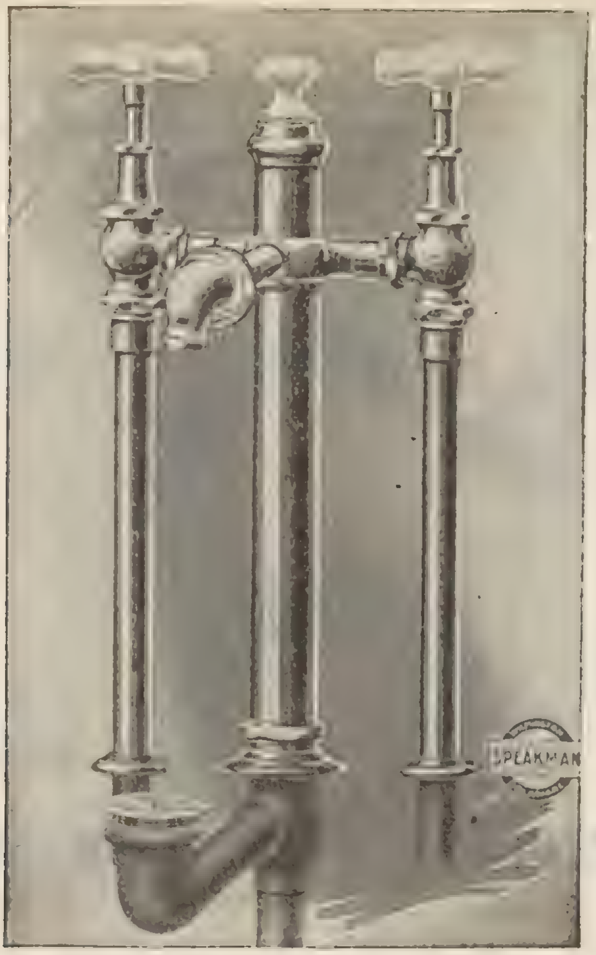
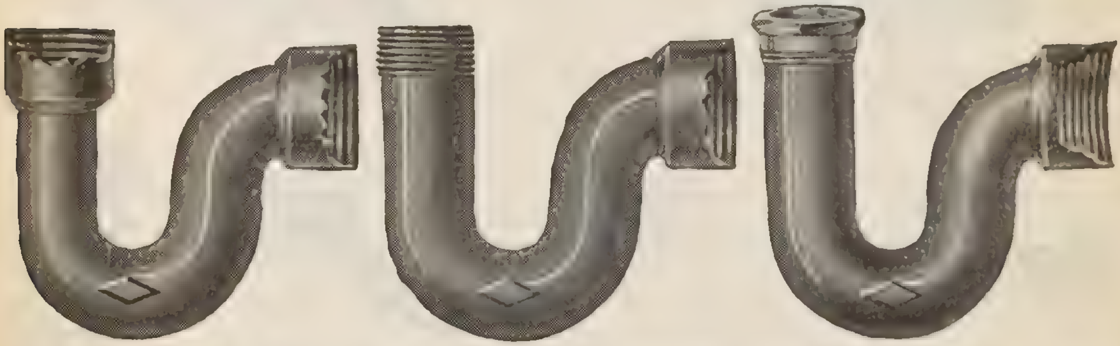


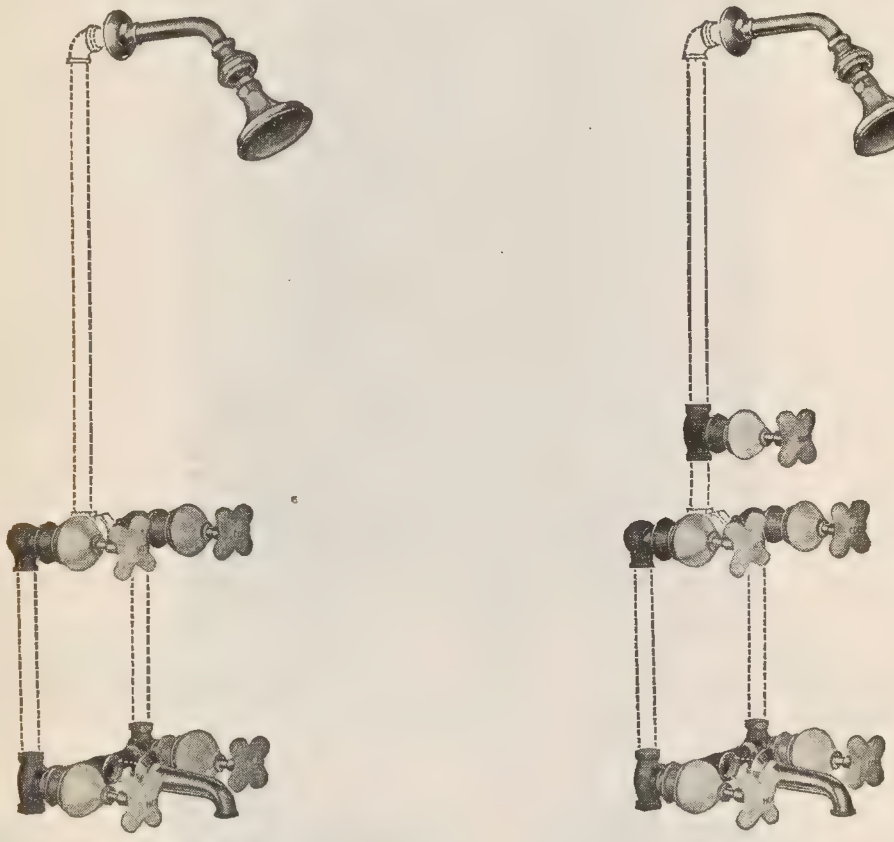
FIG. 7,509.—Speakman exposed legless bath supply and waste connections with solid china cross arm handle, top nozzle, ½ in. supplies, 2 in. standing waste with china knob for legless or low pattern tub where the waste arm is under the floor.



FIGS. 7,510 to 7,512.—Various diamond half S or P, cast iron traps. Fig. 7,510, female inlet and outlet for 1½ in. pipe; fig. 7,511, male inlet, female outlet for 1½ in. pipe; fig. 7,512, nickel plated slip joint inlet, female outlet.

Fig. 7,500 shows the special cocks and connections used where the waste control does not interfere. Here, as shown, the special cocks have the valve stem perpendicular to the plane through the outlets; this is necessary so that the valve stems will come through the wall. On the neck of the cocks are lock nuts to fasten the cocks to the wall. The general appearance of these fittings is shown in fig. 7,503.

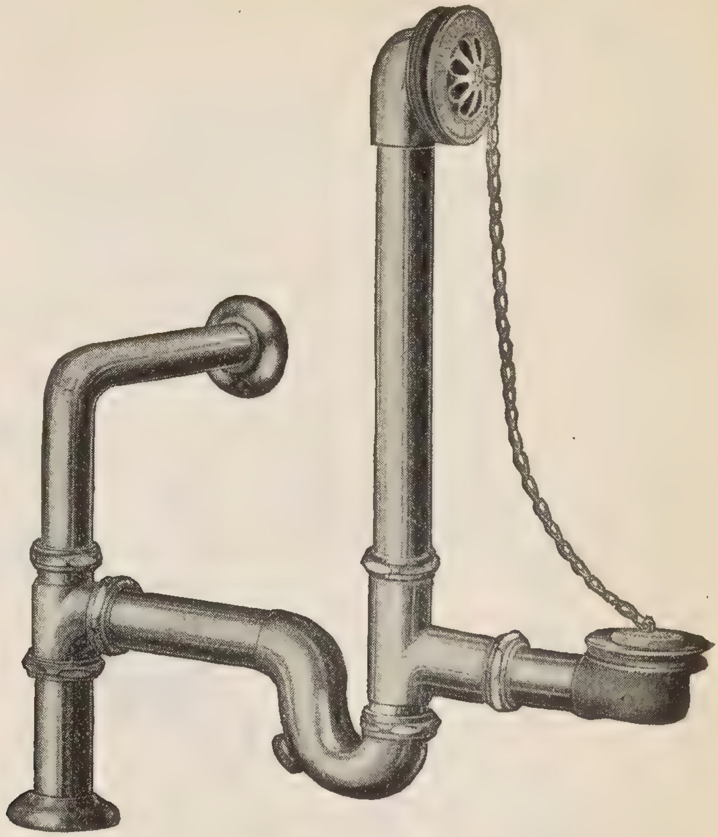
Where there is a shower, angle valves with by pass are used



FIGS. 7,513 and 7,514.—Wolverine four and five valve combination for concealed supply to tub and shower, over rim tub nozzle.

FIGS. 7,515 to 7,517.—Wolverine fittings for concealed water supply connections. Fig. 7,515, long tee $\frac{1}{2} \times \frac{1}{2} \times \frac{3}{4}$ pipe thread; fig. 7,516, special offset tee, $\frac{1}{2} \times \frac{1}{2} \times \frac{3}{4}$ pipe thread; special offset, $\frac{3}{4} \times \frac{3}{4}$ pipe thread.

FIG. 7,518.—Wolverine adjusto connected waste and overflow with vented half S or P, trap. The trap is connected direct to the waste tee so that it comes above the floor and is accessible for cleaning. The vent tube is extra long ($5\frac{1}{2} \times 10$) to allow for adjustment over high base boards.



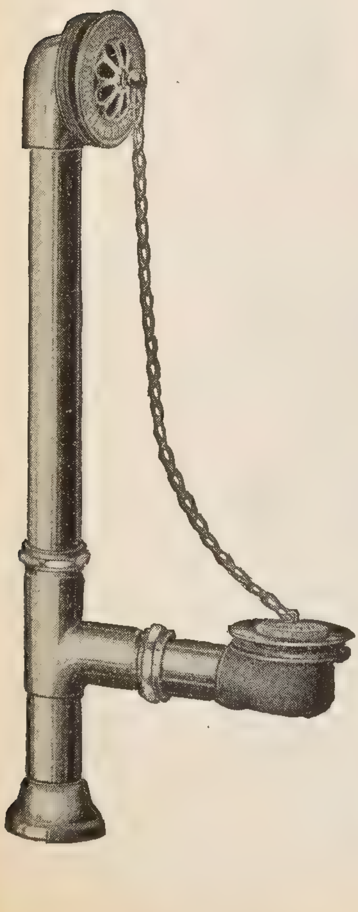
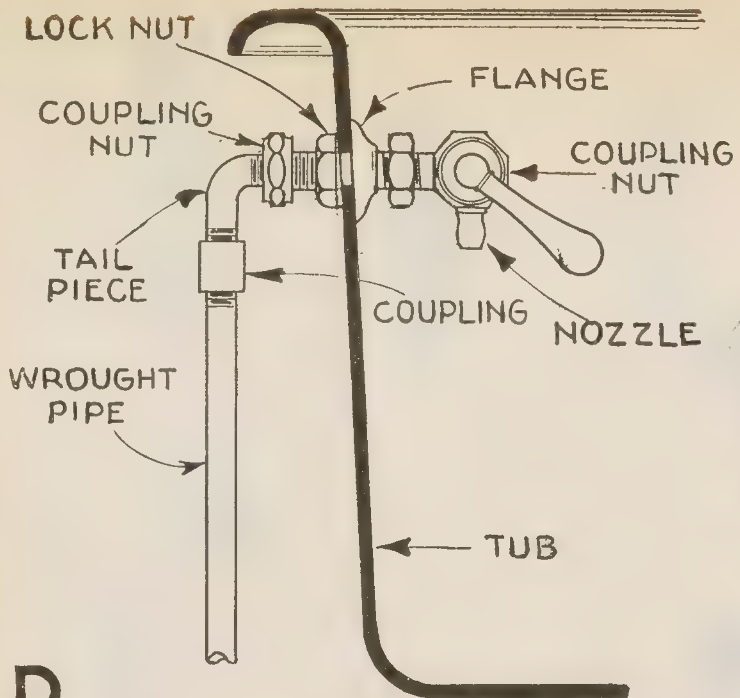
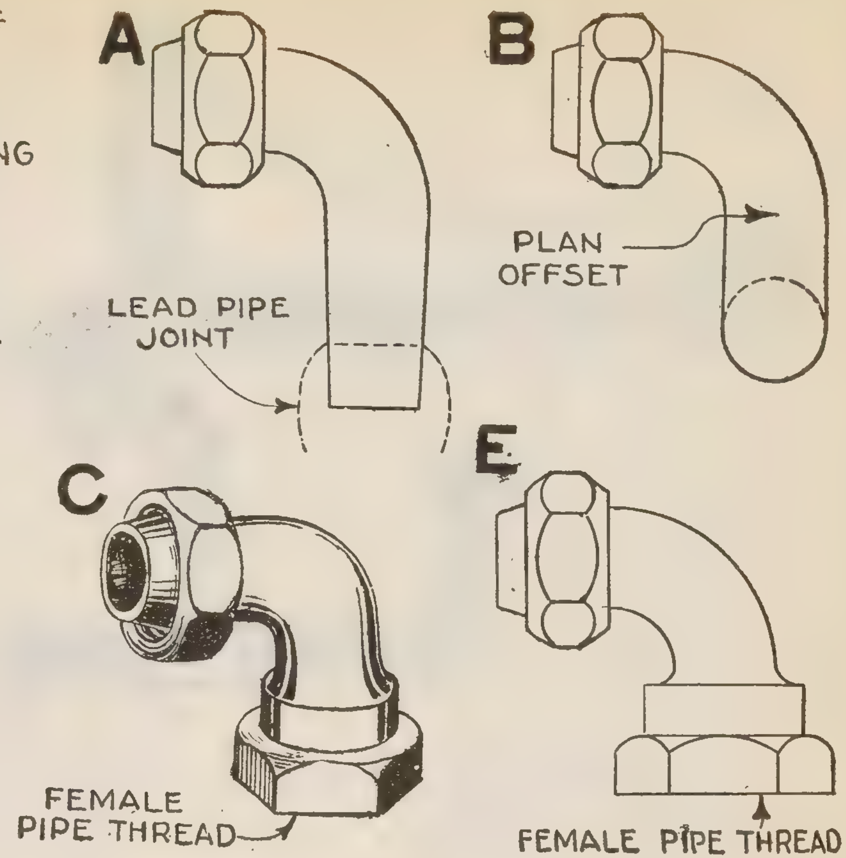


FIG. 7,519.—Wolverine connected waste and overflow with fine thread on lower end of tee. Deep flange, $1\frac{1}{2} \times 1\frac{1}{2}$ wrought pipe slip joint nut, friction ring and rubber washers; to slip into $1\frac{1}{2}$ in. wrought pipe. This design especially adapted to Durham work.





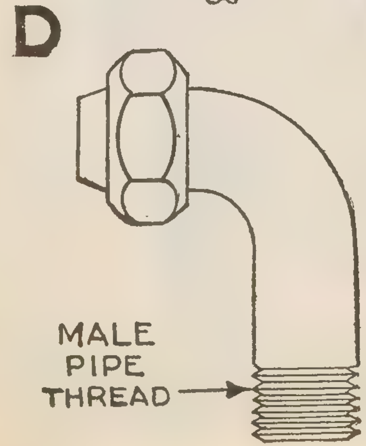


FIG. 7,520.—Top nozzle, inside connected double Fuller Bath cocks. *Elevation* showing, connections.

FIGS. 7,521 to 7,525.—Various tail pieces for bath cocks. **A**, lead pipe joint; **B**, offset; **C**, female pipe thread; **D**, male pipe thread; **E**, offset, female pipe thread.

as shown in fig. 7,503, and the general appearance of the complete assembly in fig. 7,514.

Where the waste control projects up between the supply cocks, as when a combined waste and overflow valve is used a special offset tee and offset fitting (to each nozzle) are necessary as shown in fig. 7,526.

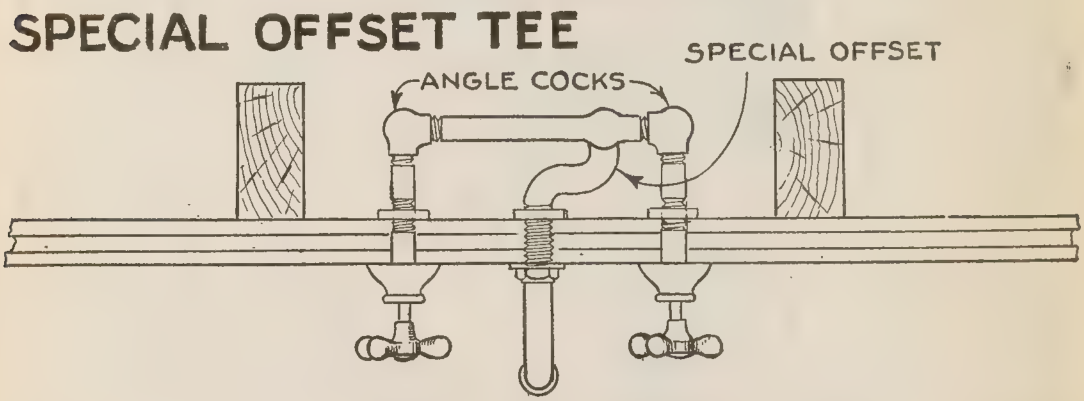


FIG. 7,526.—Concealed top nozzle water supply connections with special offset tee and special offset to avoid interference with waste control.

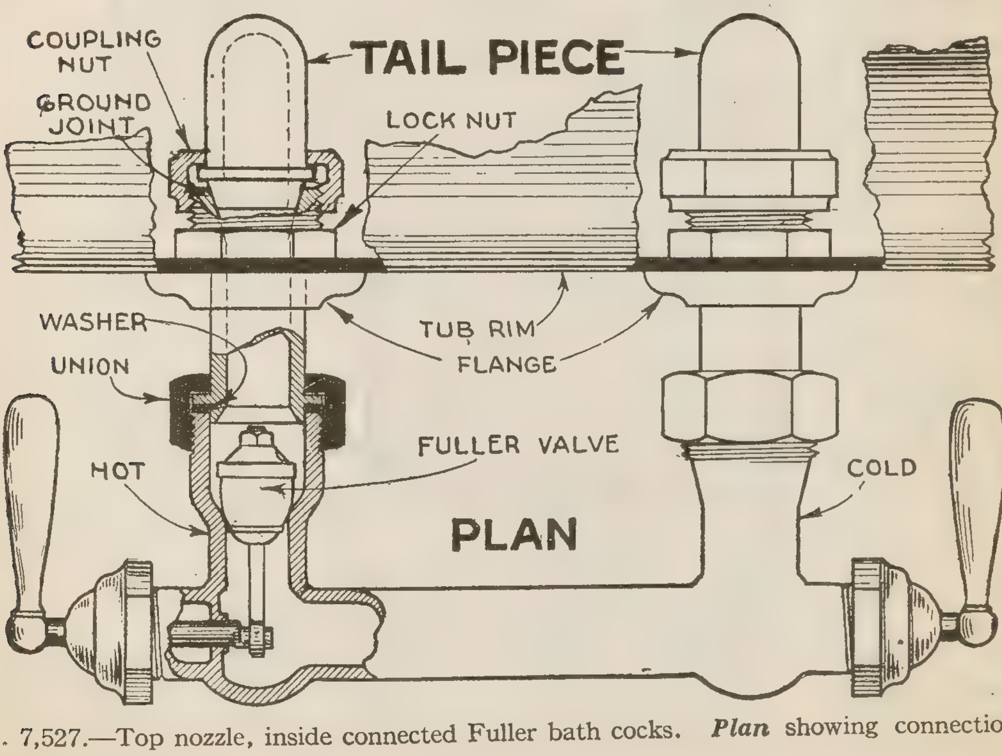
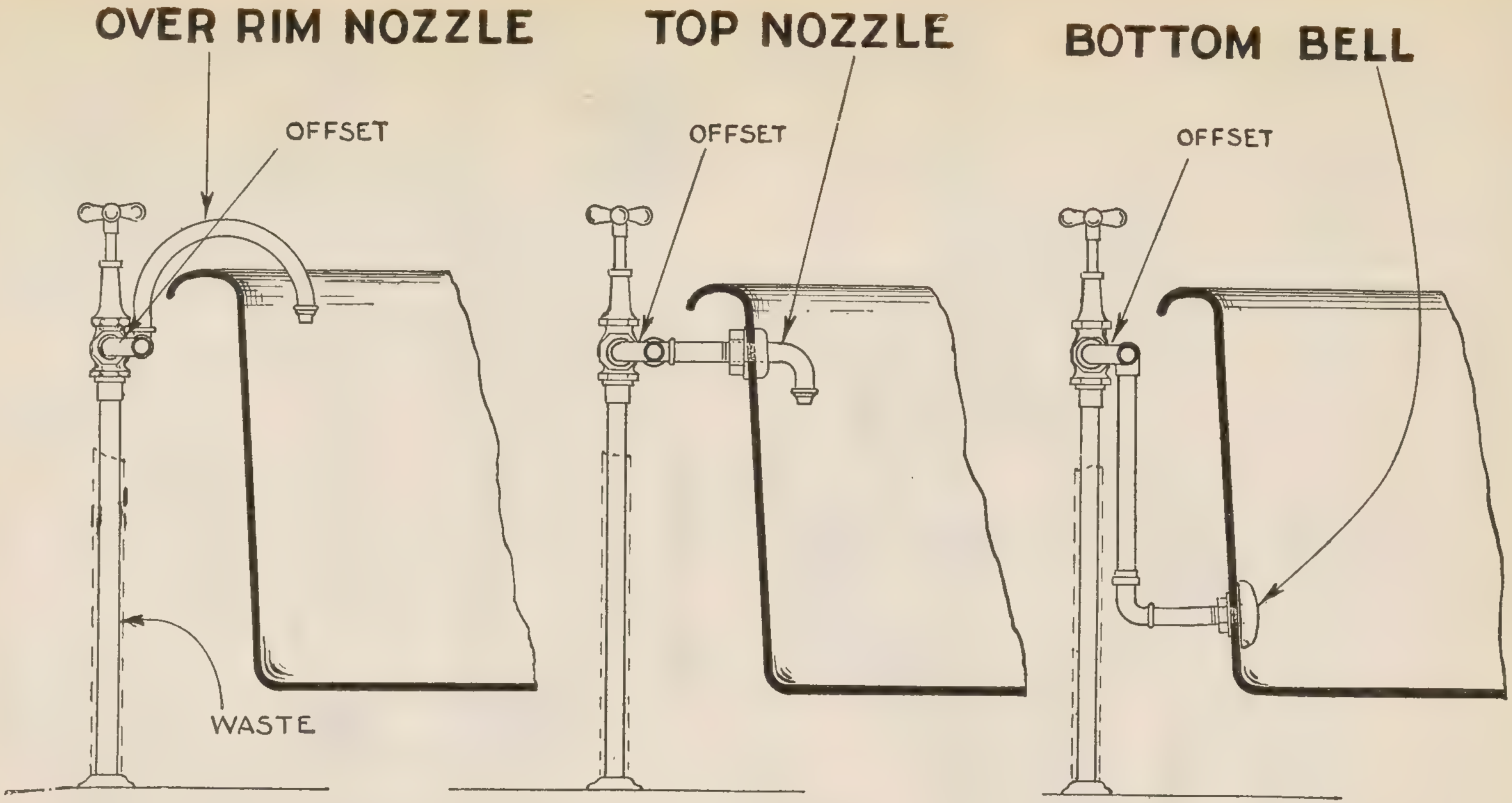


FIG. 7,527.—Top nozzle, inside connected Fuller bath cocks. *Plan* showing connections.



FIGS. 7,528 to 7,530.—Outside supply connections with various points of delivery. Fig. 7,528, over rim discharge; fig. 7,529, top nozzle discharge; fig. 7,530, bottom bell discharge.

The offset on the Tee does not show plainly in the cut as it looks up. The offset is clearly seen in fig. 7,516. The long tee and special offset connecting with nozzle are plainly shown in figs. 7,515 and 7,517.

With top nozzle supply the cocks may be either inside the hub or back of the rim. Figs. 7,527 and 7,520 show the former arrangement with Fuller cocks in section and full. The assembly is also made with compression cocks.

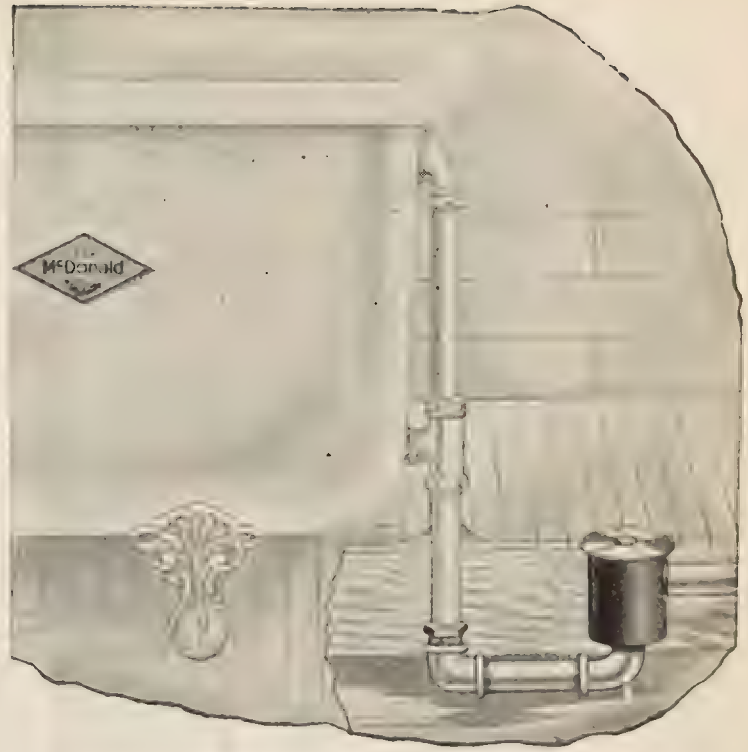
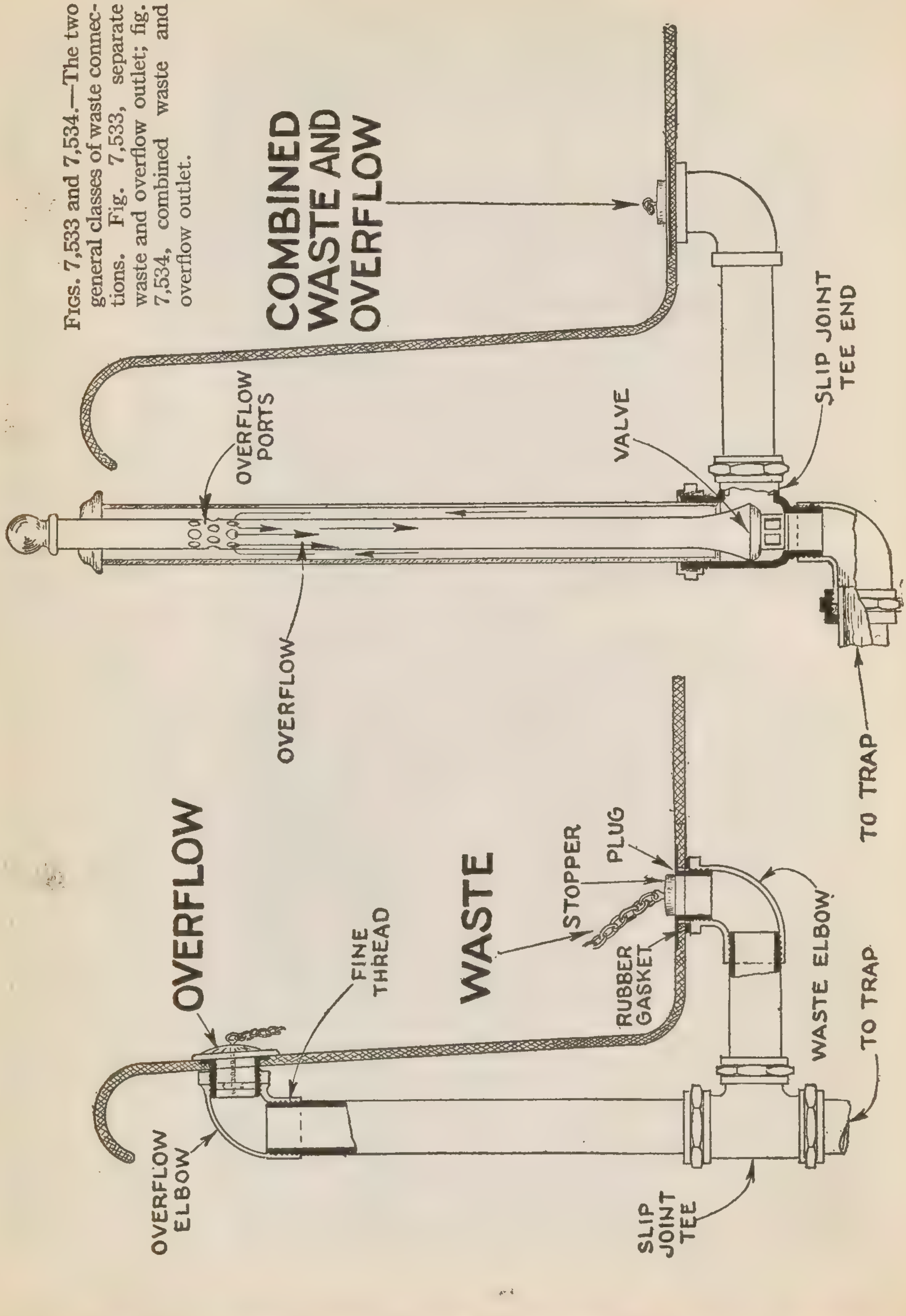


FIG. 7,531.—Diamond half S or P, cast iron trap and separate waste and overflow connections. The trap is threaded female at inlet and outlet. Since the inlet is practically level with the top of outlet the trap is below the floor. A brass soldering bushing is soldered on lower end of waste tube and the latter screwed into inlet of trap.

FIG. 7,532.—Diamond "twentieth century" drum trap and separate waste and outlet connections. The inlet and outlet of the trap have pipe threads. The outlet can be placed in any direction, thus making position adjustable. Trap and connections can be used where joists are only 8 ins. between lath and floor. Top of trap is flush with floor, accessible for cleaning.



FIGS. 7,533 and 7,534.—The two general classes of waste connections. Fig. 7,533, separate waste and overflow outlet; fig. 7,534, combined waste and overflow outlet.

To meet the conditions of any particular installation, various forms of tail piece can be obtained as shown in figs. 7,521 to 7,525.

The arrangement for cocks outside the tub is shown in fig. 7,535. Here, because of the interference due to the waste overflow column projecting up to the level of the supply valves, an offset connection is used connecting the cocks to the nozzle. The connections for the various points of discharge are shown in figs. 7,528 to 7,530 the waste column being shown in dotted lines to illustrate the necessity for the offset.

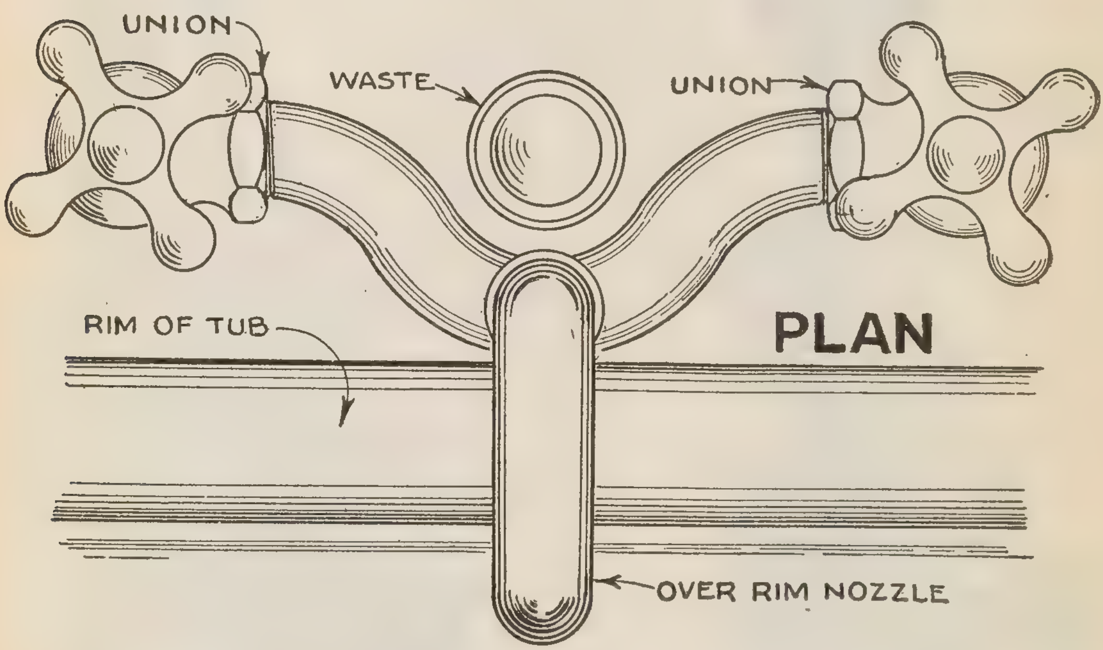


FIG. 7,535.—Over rim nozzle outside connected compression bath cocks. *Plan,* showing offset connecting fitting necessary to avoid interference with the waste overflow column.

Bath Tub Waste Connections.—There are two general classes of waste connections, distinguished with respect to the method of overflow, as

1. Separate waste and overflow outlets.
2. Combined waste and overflow outlet.

These two general classes of waste connections are shown respectively in figs. 7,533 and 7,534.

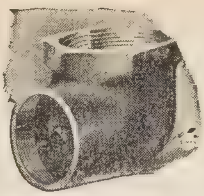
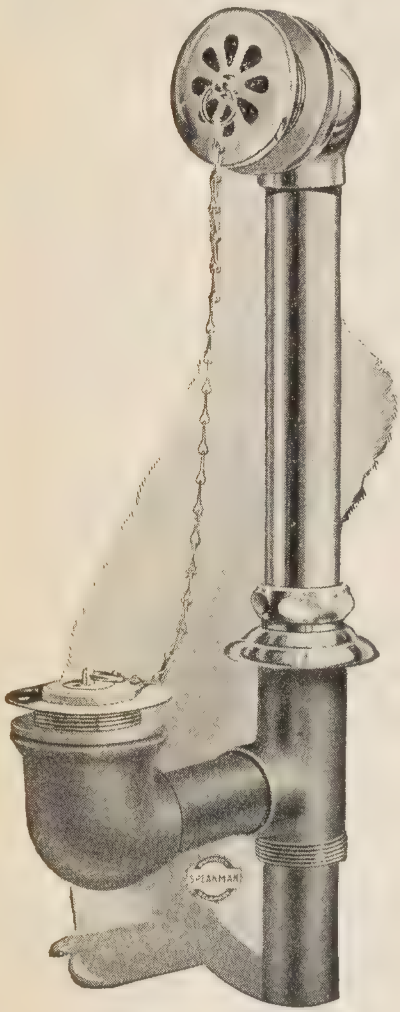


Fig. 7,536.—Special elbow for bath waste where the flow is shallow. This elbow has 1½ in. female pipe thread at one end and female fine thread at the other. It can be secured on the waste tee and the perpendicular tail screwed into the elbow making a horizontal tail.



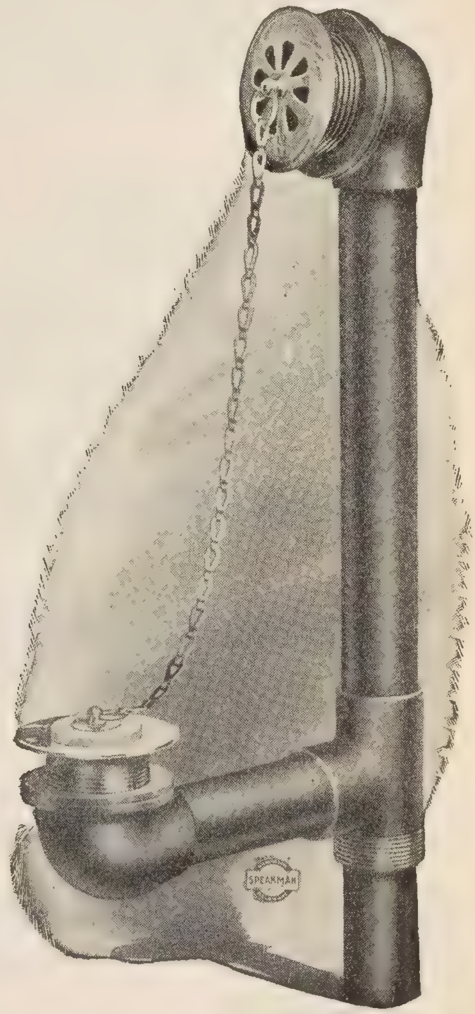


Fig. 7,537.—Speakman concealed connected waste and overflow with 1½ in. *o. d.* tail piece. The waste outlet is also threaded 1½ in. male pipe thread, hence, if desired, the tail piece may be discarded and wrought pipe connection can be used. The tee on the waste can be reversed, bringing the outlet parallel with the arm for limited space in floor.

Fig. 7,538.—Speakman exposed connected waste and overflow for legless or low pattern tub, with 1½ in. *o. d.* tail piece. Waste outlet 1½ ins. male pipe thread for wrought pipe connection instead of tail piece if desired.

Owing to the slip joints provided on the fitting, the work of making the waste connection is made easy and requires no special skill. In connecting the waste plug and overflow, sometimes owing to the slant of the tubs beveled washers are necessary, however on some tubs provision is made to offset the slant by a boss or projection.

Shower Bath.—With respect to the disposition of the waste shower baths are of two general classes as 1, those which dis-

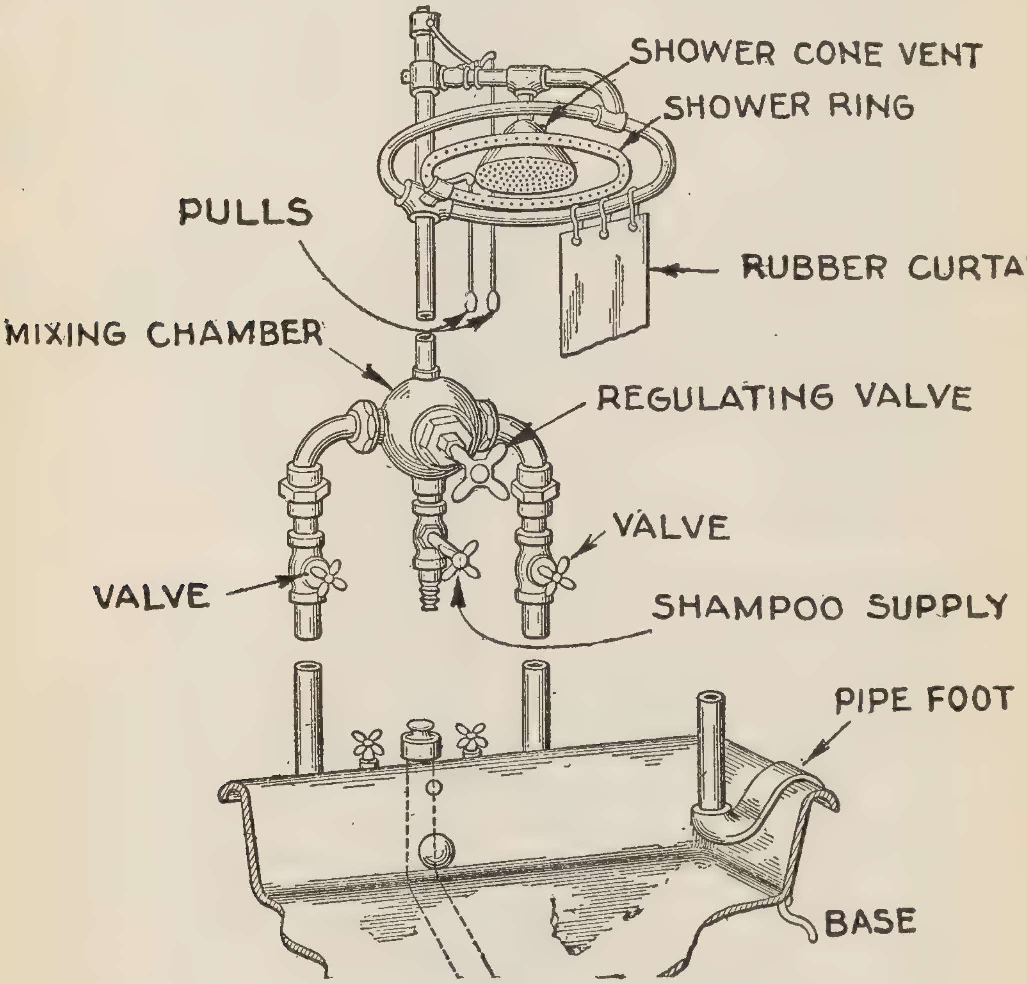


FIG. 7,539—Shower bath supply fittings and receptor.

charge into the bath tub, and 2, those which discharge into a separate *receptor* or floor pan. The latter kind strictly speaking constitutes a shower bath, the other being simply an attachment to a bath tub.

It is said that those who have studied the hygenic effects produced by the action of jets or streams on the surface of the body, urge very strongly that the impact results in stimulating the proper action of the skin. This is the opinion with most persons who have had experience with shower baths. Figs. 7,542 and 7,543 illustrate two forms of shower with receptor.

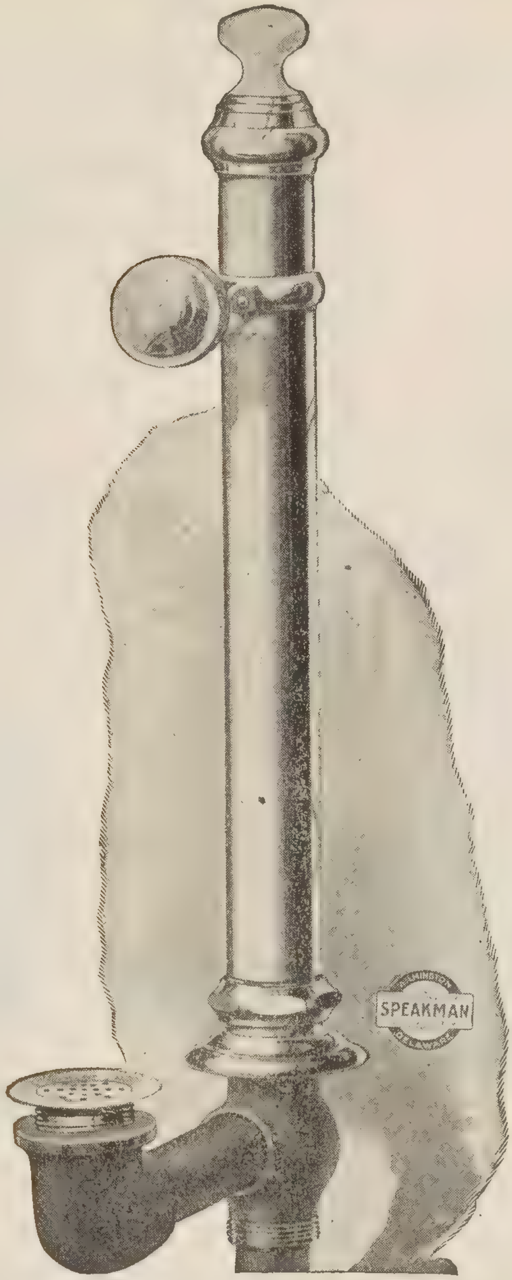
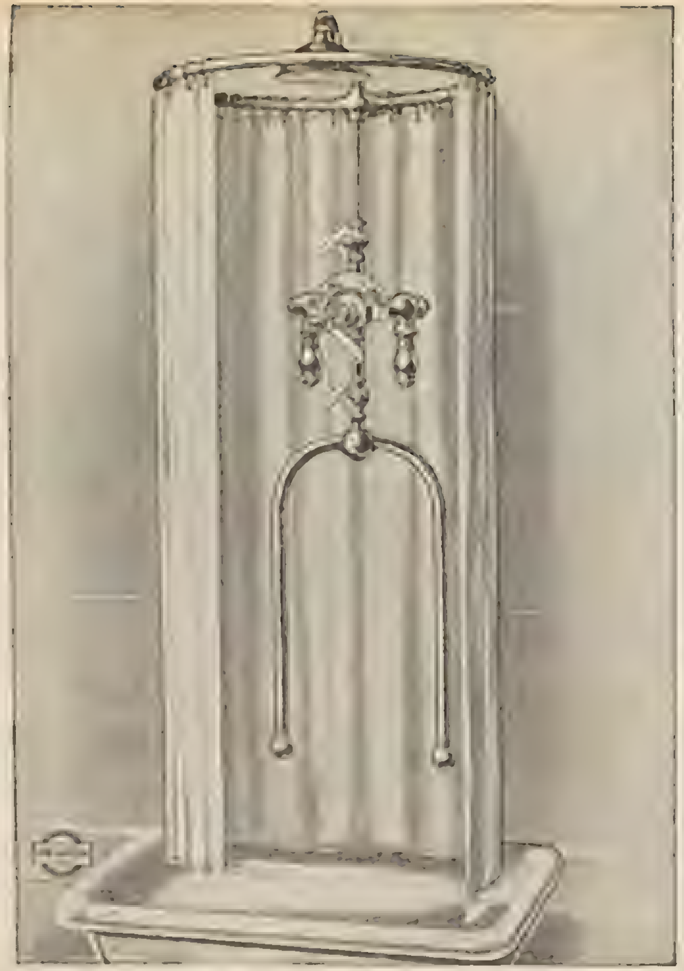


FIG. 7,541.—Speakman standing legless bath waste with china knob for legless or low pattern tub where the waste arm is under the floor.



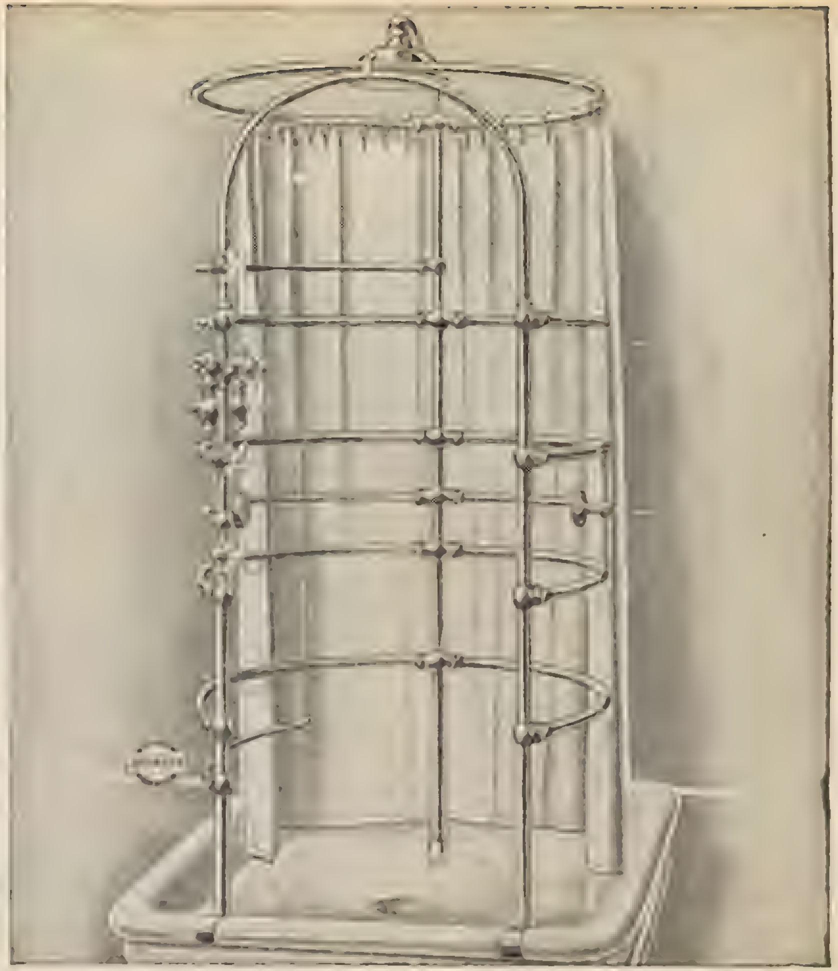
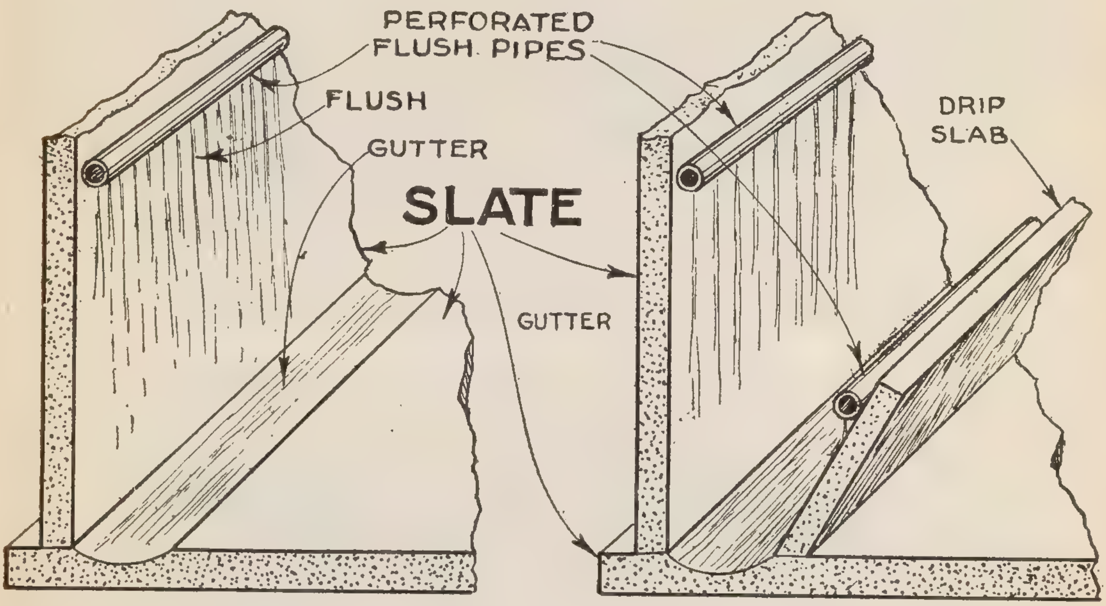


FIG. 7,542.—Speakman mixing valve shower and needle bath with $\frac{1}{2}$ in. mixing valve, elbow strainer unions, 24 X 30 oval curtain ring and white duck curtain.

FIG. 7,543.—Speakman mixing valve shower and needle bath with $\frac{3}{4}$ in. mixing valve having elbow strainer unions on the front column, lower sprays, bidet and white duck curtain. The valve is located conveniently at the front.

Urinal.—By definition a urinal is *a fixture for men's use in urinating, to receive and carry off discharged urine.*

As the urinal is installed in public places it is subject to hard usage; this coupled with lack of attention in cleaning soon results in a disgusting condition, with such dissatisfaction that the water closet is frequently used in place of the urinal. While this practice is entirely sanitary the water closet is too low for convenient use as a urinal.



FIGS. 7,544 and 7,545.—Gutter urinals. Fig. 7,544, plain; fig. 7,545, with drip slab. The gutter should be formed by a groove cut in the slate slab as shown instead of an iron casting, as the latter would be attacked by the urine and corrode. The flush pipe in an ordinary galvanized wrought pipe having small holes drilled properly spaced.

Owing to the improper use of the urinal, through carelessness, and the disagreeable properties of urine, its construction should be of a material that is non-absorbent and non-corrosive. Wood or iron should never be used, as the one absorbs the urine and soon gives off offensive odors; the other quickly corrodes. The two materials best suited for the purpose are slate and vitreous china.

There are several types of urinals known as:

1. Gutter.
   a. Plain.
   b. With drip slab.
2. Trough.
3. Individual wall.
4. Pedestal.
5. Stall.

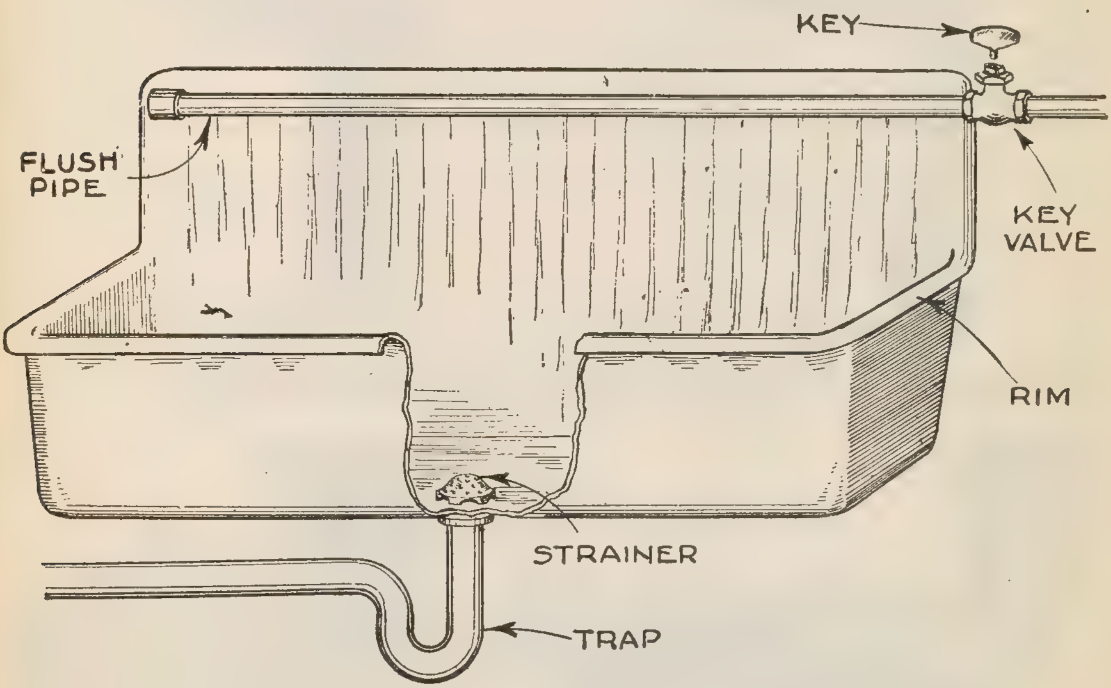


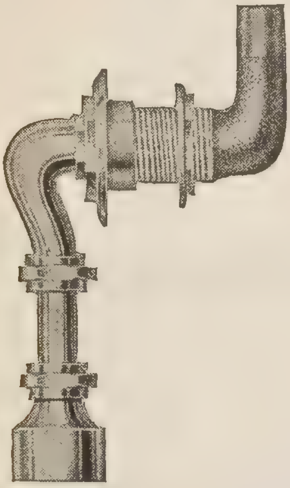
Fig. 7,546.—Enameled iron trough urinal showing fittings on flush pipe, key valve, strainer and trap.

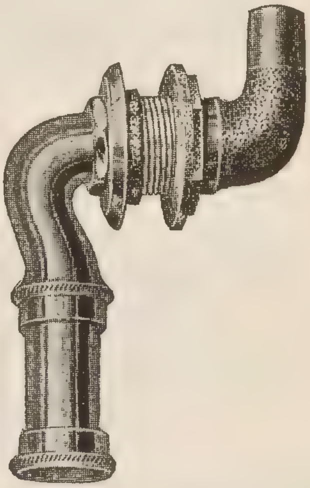
Figs. 7,544 and 7,545 show the plans and drop slab types of gutter urinals. Owing to the splash and consequent wetting of the floor an improvement on the gutter urinal is the trough form shown in fig. 7,546.

In this construction a trough is fastened to the wall at convenient height having a back a foot or so higher than the front edge. The trough usually consists of an enameled iron casting provided with a flush for front and

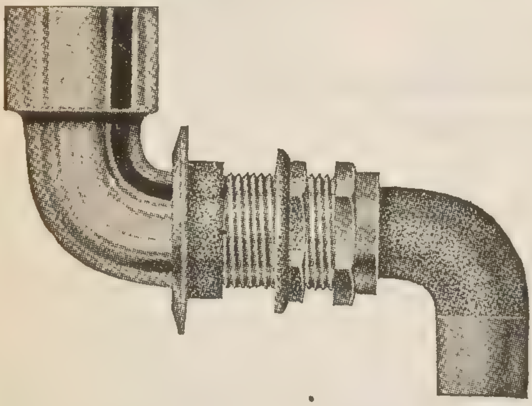
back as shown in fig. 7,546. As usually constructed the back and trough are one casting; this is an important feature as it avoids a joint. The wall hangers are concealed behind the back.

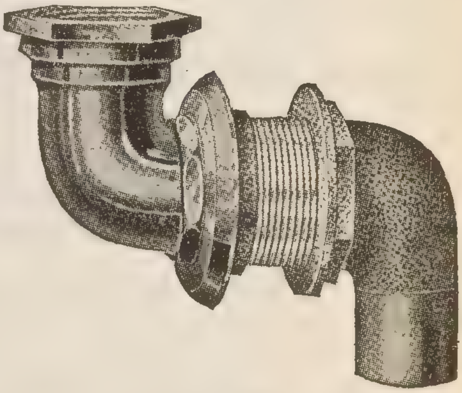
The individual wall urinal is largely used and there are several types.





FIGS. 7,547 and 7,548.—American Foundry cast brass urinal ***inlet*** connections. Fig. 7,547, adjustable with slip joints, permitting joints being made up tight from front of stall; fig. 7,548, adjustable for syphon jet urinals, made for 1¼ and 1½ in. brass spuds.



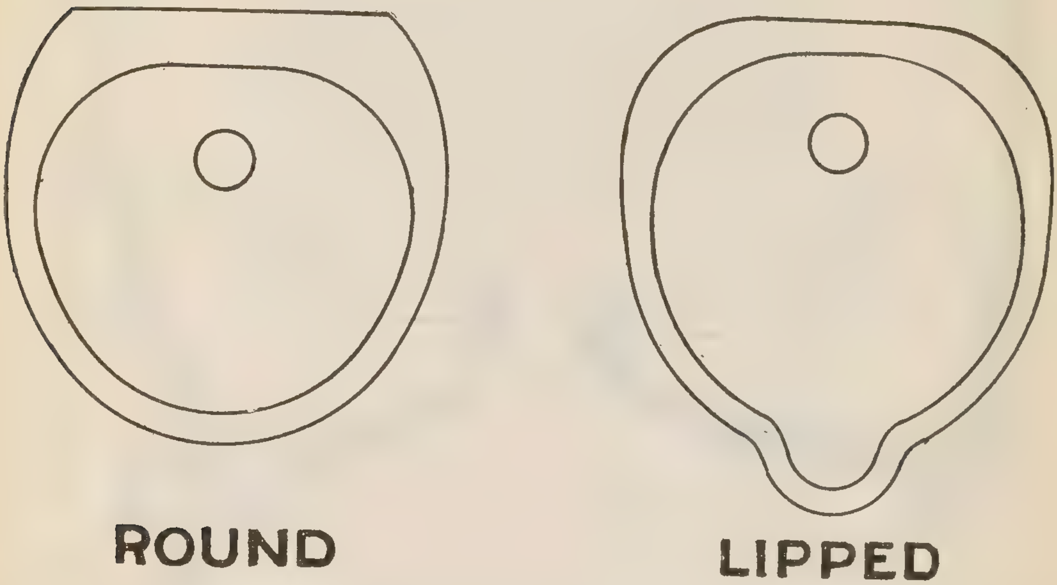


FIGS. 7,549 and 7,550.—American Foundry cast brass urinal ***outlet*** connections. Fig. 7,549, adjustable flange and bent coupling with slip joint at wall; fig. 7,550, adjustable for syphon jet urinals made for 1½ and 2 in. brass spuds.

It consists of a bowl attached to the wall at a convenient height having means for flushing and discharging the waste. The bowl is made in two general shapes known as round and lipped as indicated in figs. 7,551 and 7,552. The lipped form is more desirable than the round because it catches the drippings better.

There are several methods of flushing as

1. Wash out.
2. Syphon jet.



FIGS. 7,551 and 7,552.—The two general shapes of individual wall urinals. Fig. 7,551, round; fig. 7,552, lipped.

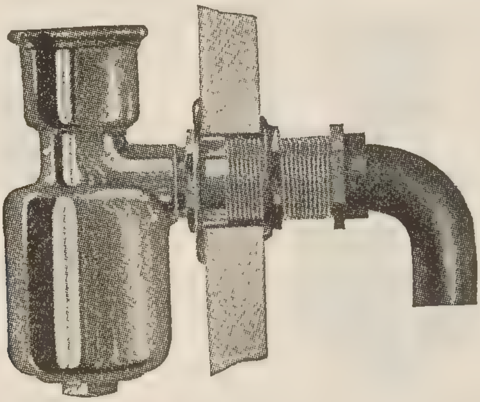
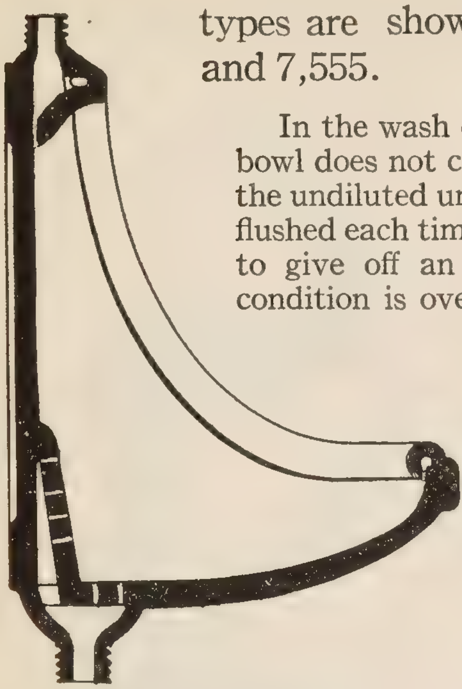


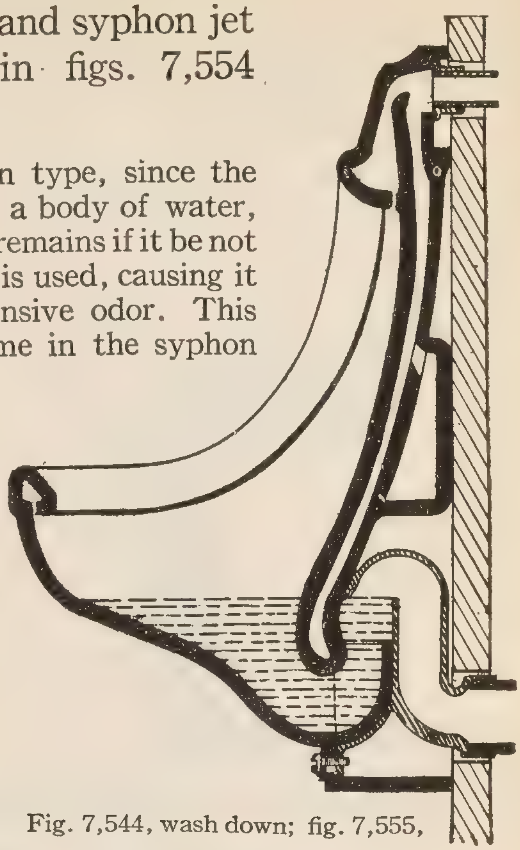
FIG. 7,553.—American Foundry brass urinal trap with slip joint at wall, clean out and bent coupling.

All lip urinals should be of the flushing rim type. The flushing rim allows the entire surface of the interior to be thoroughly cleansed at each flush.



The wash down and syphon jet types are shown in figs. 7,554 and 7,555.

In the wash down type, since the bowl does not carry a body of water, the undiluted urine remains if it be not flushed each time it is used, causing it to give off an offensive odor. This condition is overcome in the syphon



FIGS. 7,554 and 7,555.—Individual wall urinals. Fig. 7,544, wash down; fig. 7,555, syphon jet.

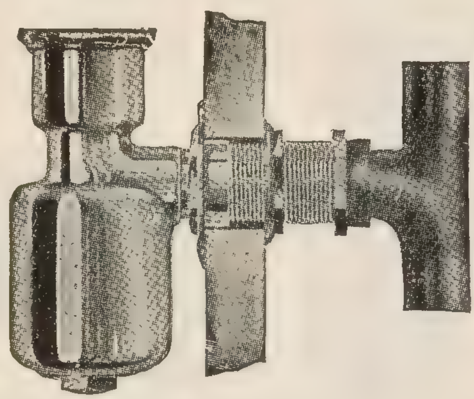
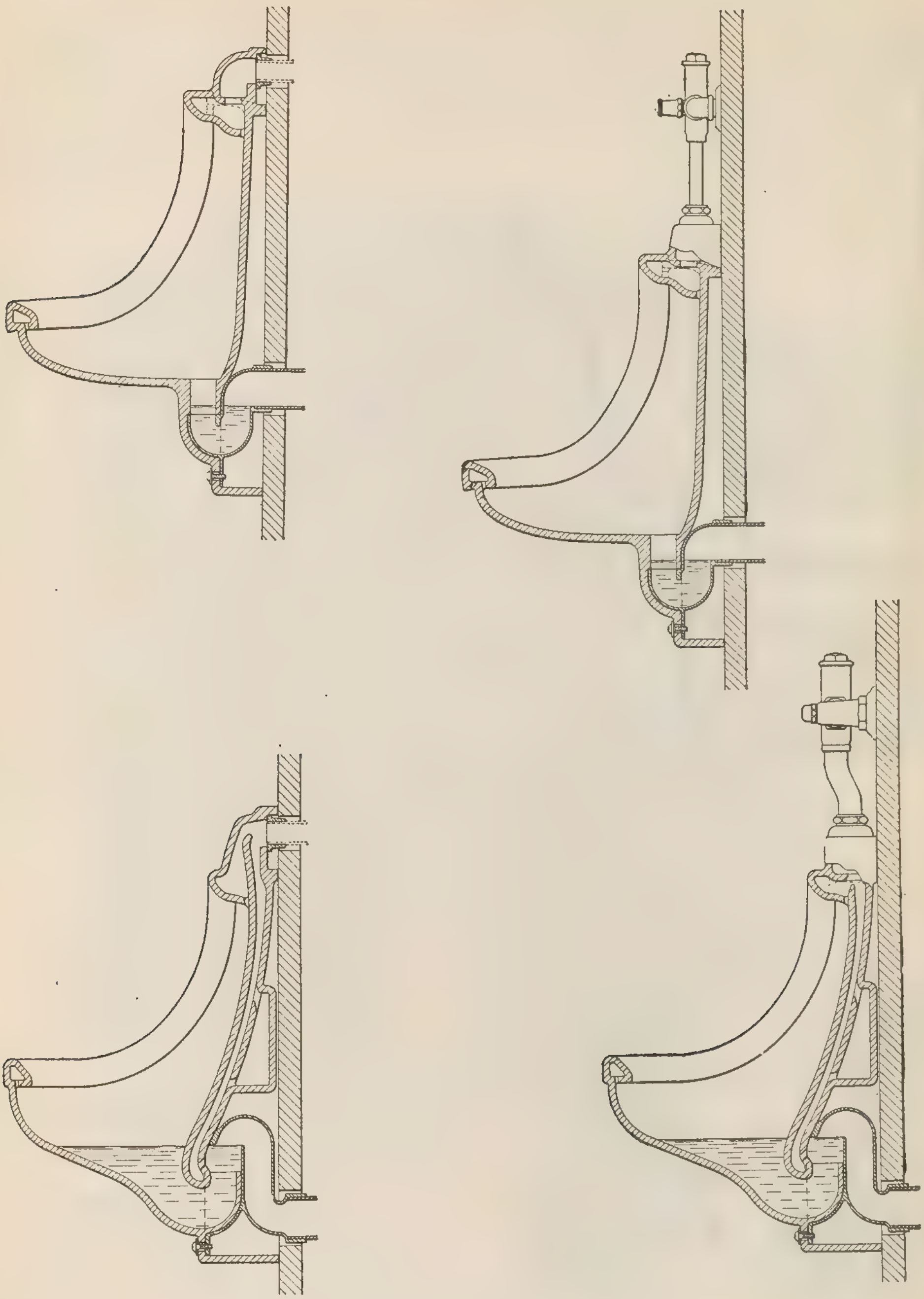


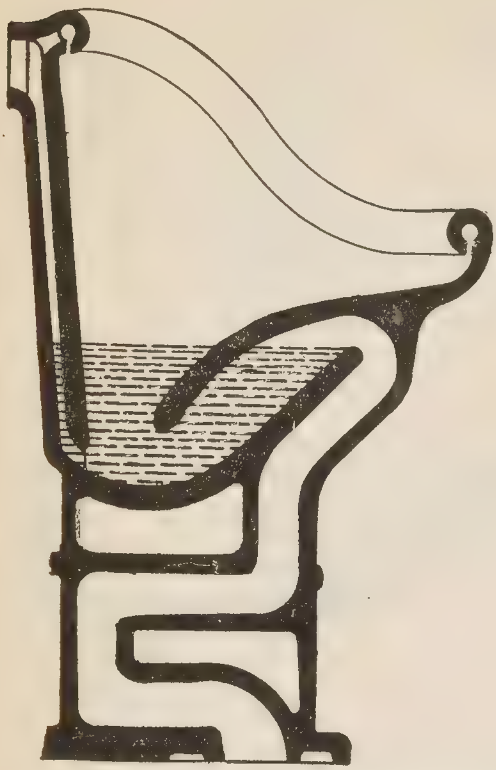
FIG. 7,566.—American Foundry brass urinal trap with slip joint at wall, clean out and combination vent and waste tee.

jet type because there is at all times a large body of water in the bowl so that the urine is immediately diluted as soon as it enters the bowl.

The urinals (and other bath room fixtures) are preferably made of vitreous china.

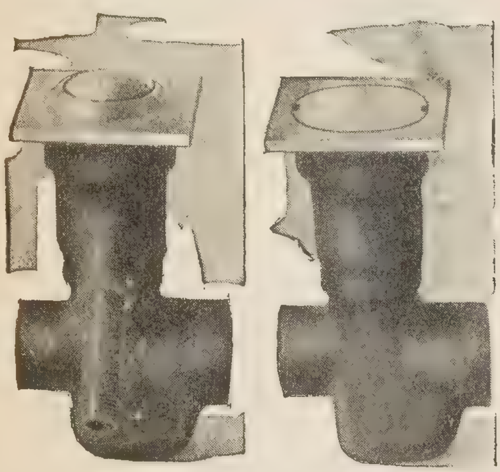


FIGS. 7,557 to 7,560.—Mott individual wall urinals. Fig. 7,557, back inlet, wash out; fig. 7,558, top inlet, wash out; fig. 7,559, back inlet, syphon jet; fig. 7,560, top inlet, syphon jet. ***The wash out type*** has a trap with deep seat, large water surface and flush rim proportioned for strong action. ***The syphon jet type*** presents a water surface of $9\frac{1}{2} \times 9$ ins. The outlet trap is of ample capacity for the passage of small articles which find their way into the urinals.



This is a clay material that is fired to a high degree of heat and becomes extremely hard. After the first firing, the hard vitrified body is covered with a glaze and the piece is again fired. The important thing to remember about vitreous china is that this firing is done at such a high

FIG. 7,561.—Maddock white vitreous china syphon jet pedestal urinal with extended lip, back inlet, floor outlet.



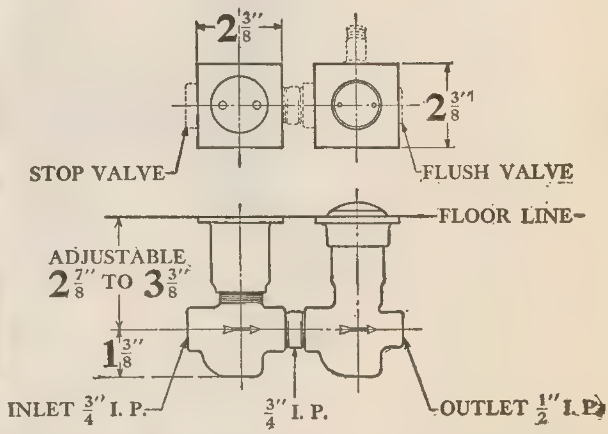


FIG. 7,562.—Mott self-closing (¾″ inlet, 1½″ outlet) foot action urinal flush valve with drain concealed in floor with white metal plate.

FIG. 7,563.—Mott regulating stop valve for use on urinal supply line, and having white metal plate.

FIGS. 7,564 and 7,565.—Plan and elevation of figs. 7,562 and 7,563 showing measurements.

temperature that the piece reaches a molten stage and the hard body and glaze becomes one homogeneous mass. Vitreous china is guaranteed not to craze, crack or discolor under the most severe usage. Acids cannot injure it. The surface is in reality a part of the body and the body itself is hard, non-porous and impervious to moisture—*vitrified*, as the name implies.

FIG. 7,566.—Mott, Mendon pattern, vitreous china syphon jet pedestal urinal with spud, Oscilla flush valve with union joint angle stop and floor flange.

Blows such as would be received from the falling of cups, tumblers and bottles, sometimes break lavatories made of common earthenware and frequently loosen the enamel on other types so that the surface chips or peels off. This cannot happen to vitreous china because the body and glaze, being one solid mass, cannot be separated.

The pedestal urinal is constructed on the same principle as

the modern water closet, inasmuch as it is flushed and cleansed by syphonic action.

It is the cleanest and best urinal made because all waste matter is removed at each flush. The opening through the trap is as large as that of most water closets and being of a syphon action type, clogging is practically impossible. This type is shown in fig. 7,561.

The stall urinal is shown in fig. 7,567. It is made of a fire

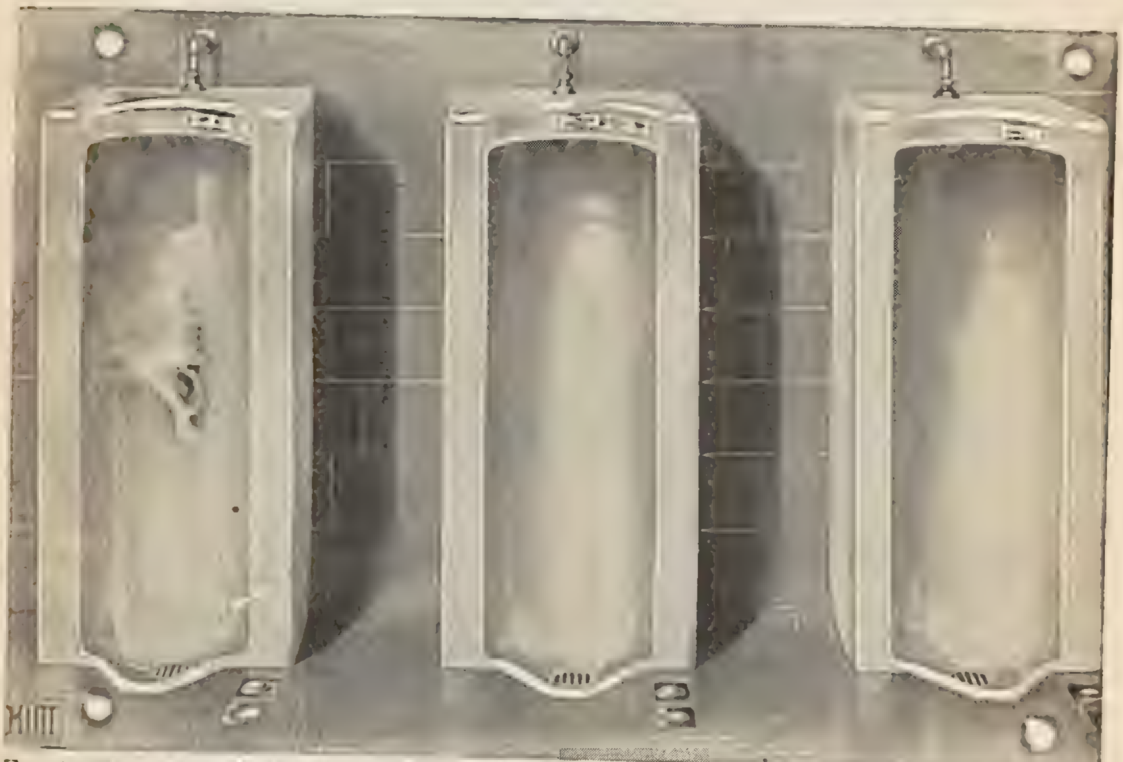


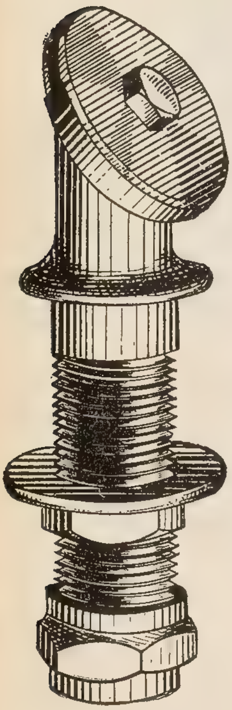
FIG. 7,567.—Mott, Sanito pattern, stall urinals. ***They are made*** in one piece with all exposed parts glazed. To provide sufficient room so that all urinals may be used at the same time, they should be spaced 27 ins. center to center. Where urinals are to be used by school children they may be set closer: a spacing of 22 ins. is considered adequate. The space between the urinals should be filled with tile or cement as shown.

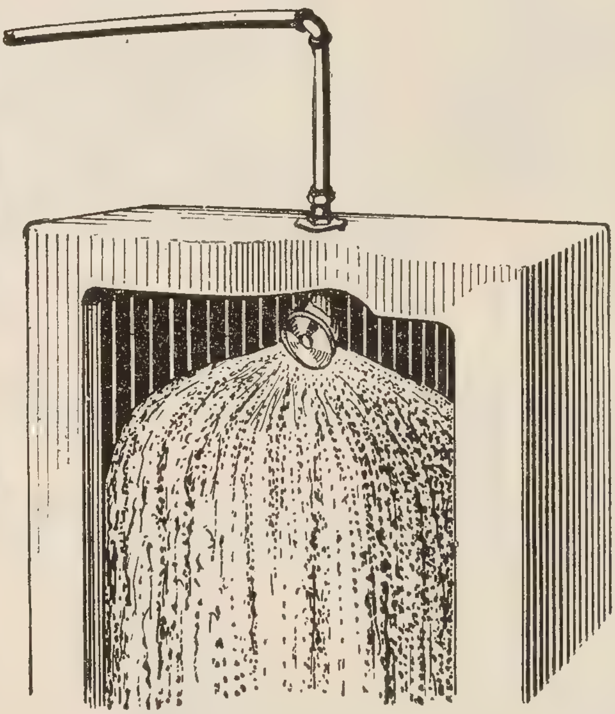
clay body and consequently it is liable to crazing which means cracks developing in the glaze.

When this happens, the soft, porous body under the glaze absorbs urine, giving off a bad odor. This condition can never be corrected because once urine is absorbed by the body it cannot be eliminated and the toilet room

becomes ill-smelling and very unsanitary. The urinal itself also becomes discolored.

There are some stall urinals made of vitreous ware. They are of small size and their cost is almost prohibitive. In these, the disadvantages of the fire clay body have been overcome, but they have all the other objectionable features of the stall urinal. The method of flushing stall urinals from the top, and the spreader fitting used as shown in figs. 7,568 and 7,569.



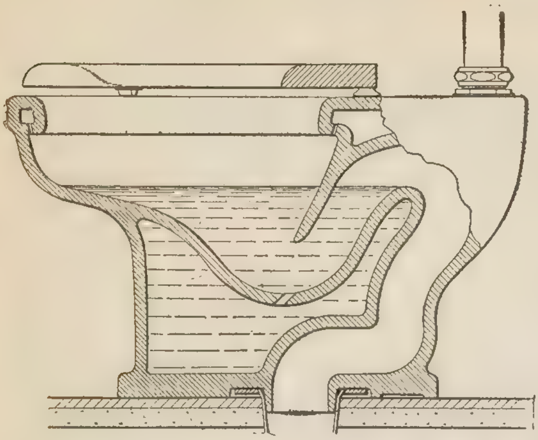


Closet.—The most important fixture of all sanitary appliances is the water closet and upon its proper construction,

Fig. 7,568.—Speakman urinal spreader; regularly made with ½ in. wrought pipe slip inlet.

Fig. 7,569.—Speakman urinal spreader as applied to a stall urinal.

NOTE.—***The oldest extant water closet in Scotland.***—It is stated to be situated in the old Bishop's Castle of St. Andrews at Dundee, now only an interesting old ruin. As described by Buchan the closet is built projecting out beyond the line of the wall 18 ins., with a flat stone for seat 22×18 ins., with large hole in center. This stone appears to have been covered with wood, and no doubt the opening had a movable lid to keep out the wind, the size of the closet apartment inside is 4 ft. 8 ins. from door to front of seat, and 2 ft. 6 ins. wide. Height from floor to ceiling 6 ft. It had a window. The drop outside from closet to high water mark is about 50 ft. The only provision for flushing the wall of the building outside and the rocks I could see was the rain and the sea. In the other corner will be seen what appears to be the stone gutter for a sink. The waste water here had a fall of 40 ft. to reach the German ocean below at high water mark. "Aye," says the Archibishop's ghost, as I write—dead as a red herring though he be—"we thocht oursels nae small beer in those days, when we were sae weel provided for in the sanitary way. Did ye no publish yoursel in 1869, that on the 27th day o' Aug. 1564, the Bailzees and Counsale o' Aberdeen had to send to Sanct Andrewes for ane plumber to reforme and mend the faltes of their kirk?"—***Buchan.***



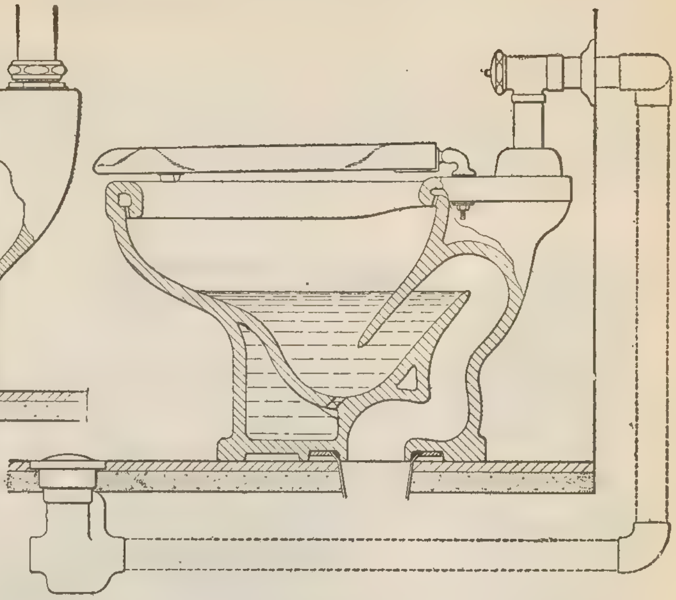
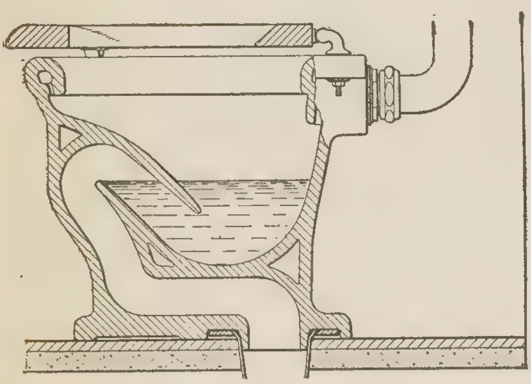


FIG. 7,570.—Mott, Silentum, syphon jet water closet with extended front lip and non-soil flushing rim. The silencing feature of this closet is an integral part of the bowl. Water surface 13 × 10 ins.; depth of seal 3¼ ins.

FIG. 7,571.—Mott, Silento, syphon jet water closet with non-soil flushing rim and concealed foot action floor valve. The aim in this design is the elimination of all unnecessary exposed brass work. ***To flush closet,*** press the exposed push button with the foot.



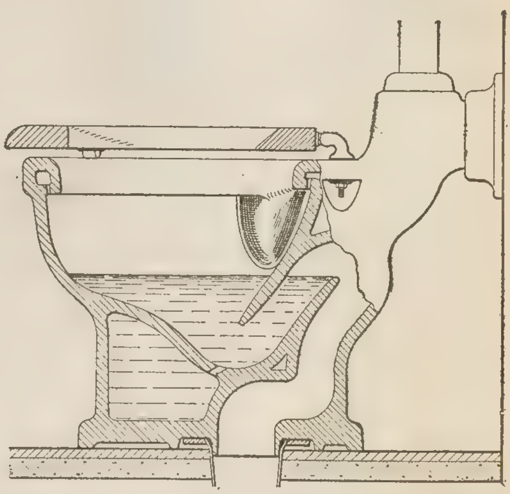
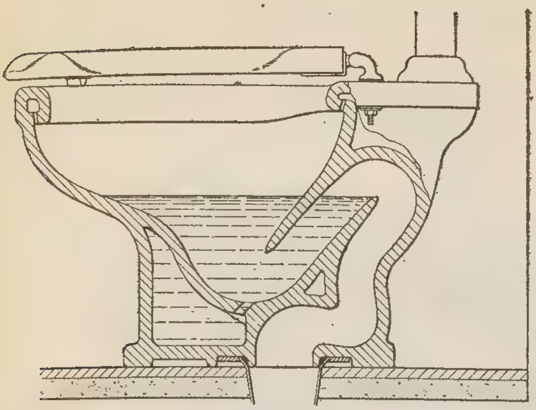


FIG. 7,572.—Mott, Lombard, syphon jet water closet with non-soil flushing rim. Water surface 12 × 16 ins., depth of seal 3 ins.

FIG. 7,573.—Mott, Lombard syphon jet water closet with Boston vent and non-soil flushing ring. The Boston vent is for local ventilation.



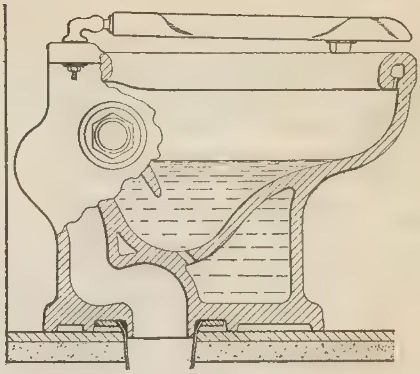
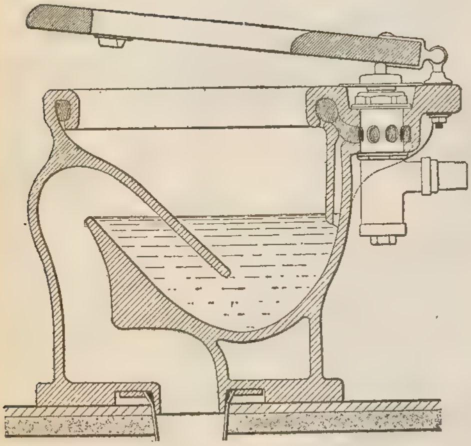


FIG. 7,574.—Mott, Lombard-Duplex syphon jet water closet with top inlet, raised seat extension, extended front lip and non-soil flushing rim. Water surface 13×10 ins.; depth of seal 3 ins.

FIG. 7,575.—Mott, Lombard-Duplex, syphon jet water closet wit hside inlet, raised seat extension, extended front lip and non-soil flushing rim.



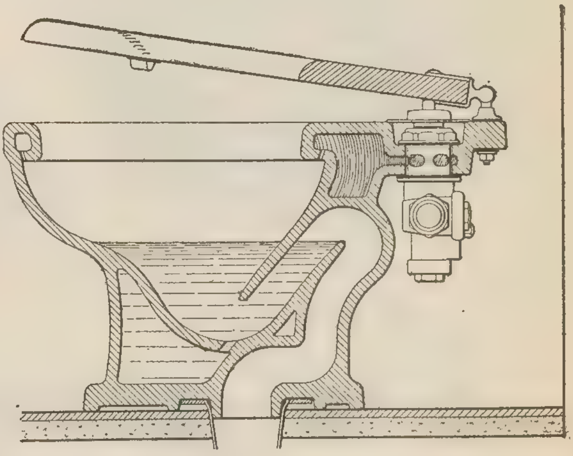
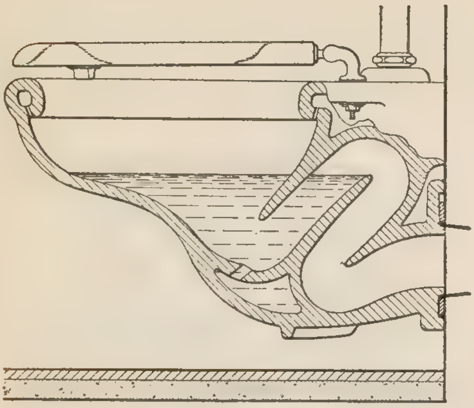


FIG. 7,576.—Mott, Attila, combined wash down and syphon water closet with automatic valve. ***In operation,*** the jet forces outward the contents of the bowl and causes syphonic action. Water surface 7×6½ ins. This closet will operate at pressures of 5 lbs. upwards provided supply be ample.

FIG. 7,577.—Mott, Attila-Lombard syphon jet water closet with automatic valve. It combines the features of the Attila and Lombard closets. Water surface 12×10 ins. Water pressure required to operate is 20 lbs.



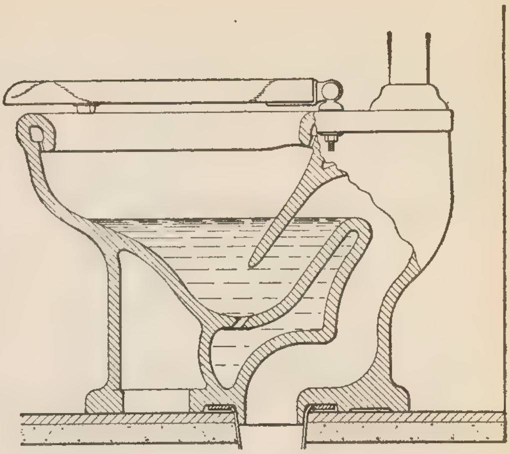
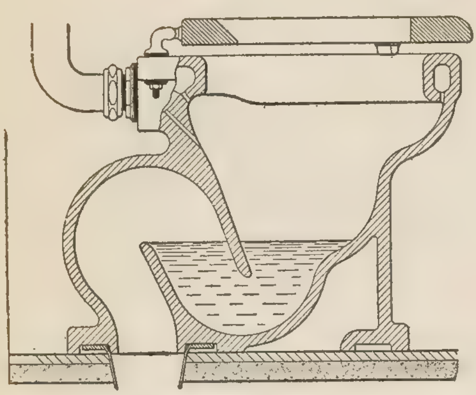


FIG. 7,578.—Mott, Suspendo, syphon jet wall hanging water closet with extended front lip and non-soil flushing rim.

FIG. 7,579.—Mott, Beekman, syphon jet water closet with non-soil flushing rim. ***The jet*** is so located as to give best results with a limited amount of water. Water surface 12×10 ins.; depth of seal 3½ ins.



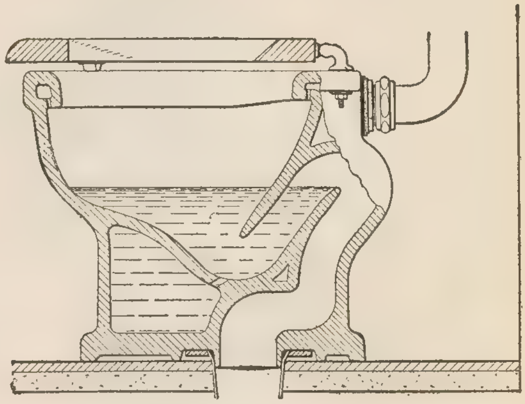


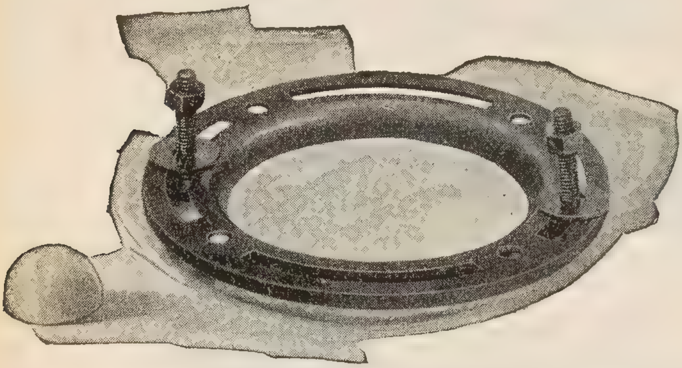
FIG. 7,580.—Mott, Titan, wash down water closet with non-soil flushing rim. ***It is designed*** to withstand rough usage as in factories. It holds a large body of water and the water way is designed to prevent obstruction, a frequent cause of annoyance and expense. Water surface 7×7¼ ins.; depth of seal 2¼ ins.

FIG. 7,581.—Mott combined wash down and syphon water closet with flushing rim. ***The jet*** strikes directly upon and forces outward the contents of the bowl and causes syphonic action. Water surface 7×8 ins.

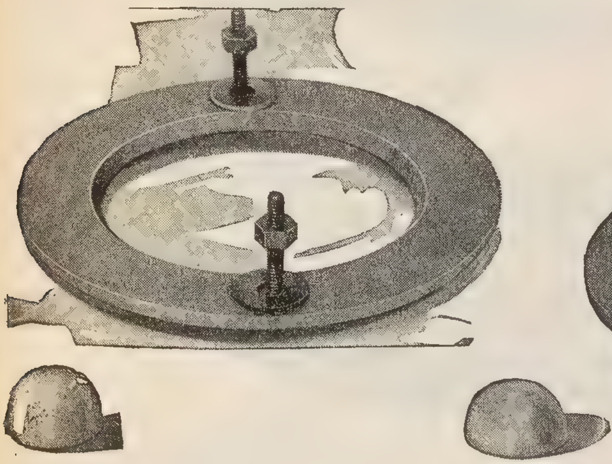
installation and operation depend the health of the occupants of the building.

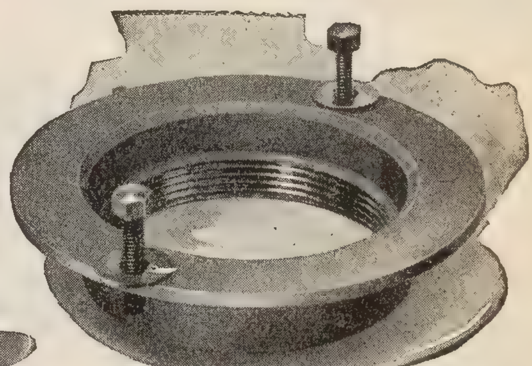
To make a water closet that will carry off human waste, that will be self cleansing, sanitary, non-soiling and at the same time noiseless in operation has been no small task to accomplish.

The principles of operation of the various types of closet have



FIGS. 7,582 and 7,583.—Mott cast brass floor flange with two bolts and china caps.





FIGS. 7,584 and 7,585.—Mott extra heavy cast brass floor flange for lead with two bolts and china caps.

FIGS. 7,586 and 7,587.—Mott extra heavy cast brass floor flange pipe thread (female) with two bolts and china caps.

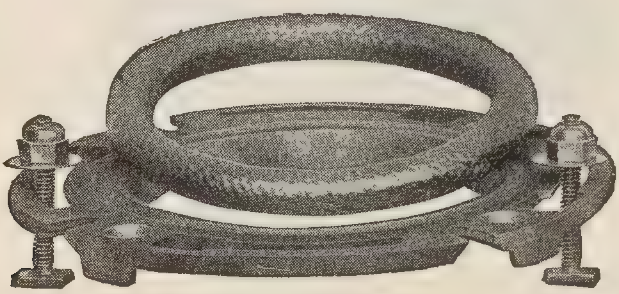


FIG. 7,588.—Standard brass closet floor flange for use with regular horn outlet.

already been presented in the chapter on Drainage, hence it is not necessary to repeat them here.

The syphon jet is the only style of water closet on which a noiseless feature can be attached. It should be remembered that if a really quiet acting closet is wanted, it must be operated by a low pattern tank and not by a flush valve.

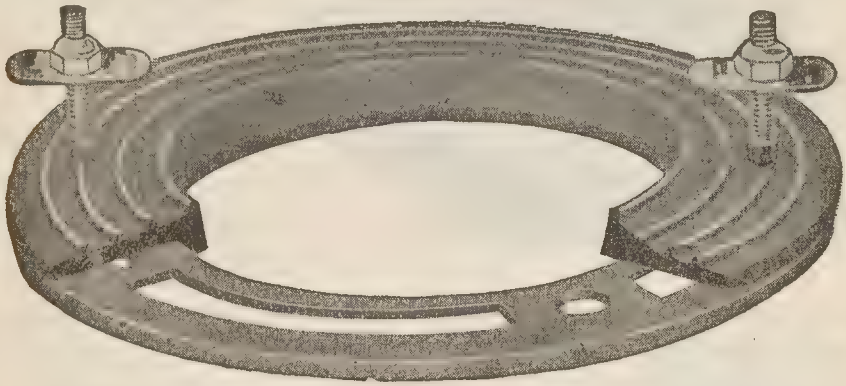


FIG. 7,589.—Wolverine closet floor flange with lip gasket, bolts and washers.

FIG. 7,590.—Wolverine cast brass R. T. flange with R. T. asbestos gasket; 9/16 in. lower lip, bronze bolts with nickel plated heads and washers.

FIG. 7,591.—Mott cast iron floor flange to caulk over 4 in. soil pipe, with two bolts and china caps.

While the silent feature reduces the noise when the valve is used, the closet will not work as quietly with an automatic valve as it will under a low pattern vitreous china tank. Figs. 7,570 to 7,581 show types of closet in general use.

An important part is the connection of the closet to the soil pipe.

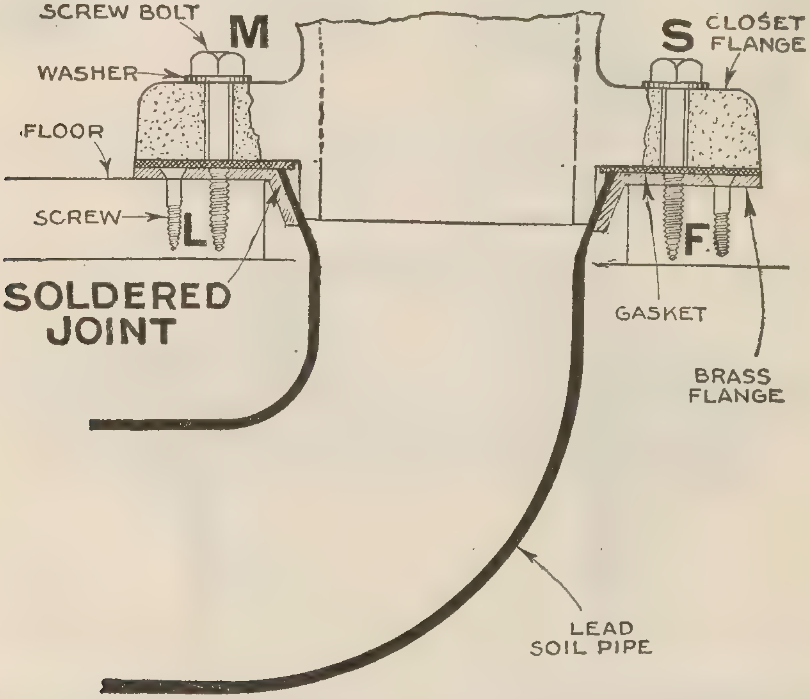
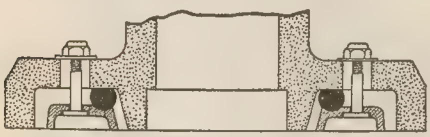
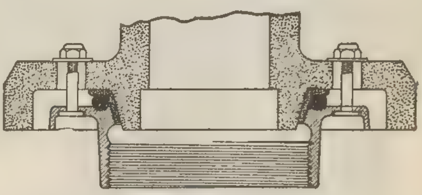


FIG. 7,592.—Lead pipe elbow closet soil connection with brass floor flange. The brass flange is secured to the floor by screws L,F, and the lead elbow soldered to the flange as shown. A rubber gasket is placed between the brass flange and the closet flange and the latter bolted to the brass flange by bolts M,S, thus making a tight connection.

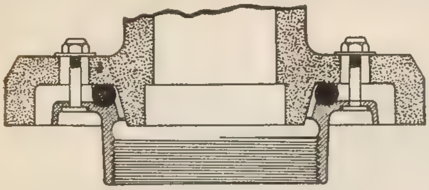


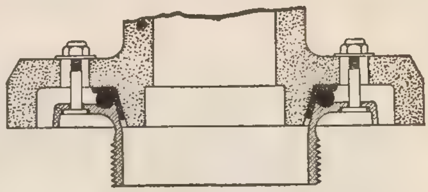


FIGS. 7,593 and 7,594.—Standard closet floor flanges. Fig. 7,593, cast brass (for Universal outlet bowls) with asbestos ring gasket and bolts ***for lead pipe connection;*** fig. 7,594, cast brass (for Universal outlet bowls) with asbestos ring gasket and bolts ***threaded 4 in. pipe thread female.***

The old method of using putty to make a tight joint should not be tolerated as it is rarely tight.

Closets are commonly attached by means of a brass floor flange, some forms of which are shown in figs. 7,582 to 7,591. The method of making a joint with the type flange shown in fig. 7,585 is illustrated in fig. 7,592. Similarly construction of other types of soil joint are shown in figs. 7,593 to 7,602.





FIGS. 7,595 and 7,596.—Standard closet floor flanges. Fig. 7,595, cast brass (for Universal outlet bowls) with lead and asbestos ring gaskets and bolts, threaded 4 in. pipe threads ***female;*** fig. 7,596, cast brass (for Universal outlet bowls) with lead and asbestos ring gasket, and bolts, threaded 4 in. pipe thread, male.

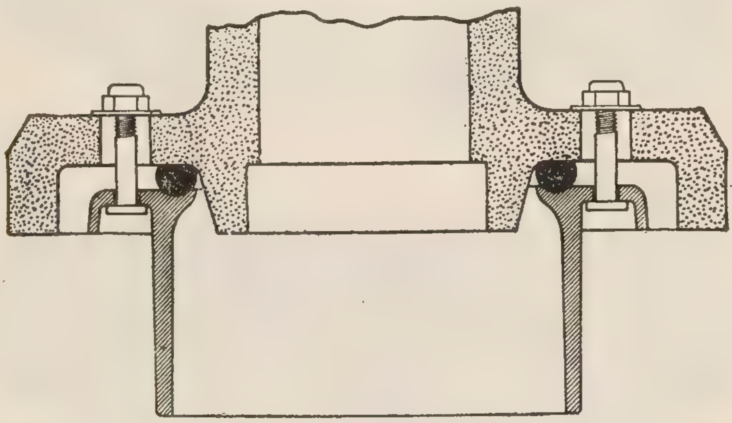
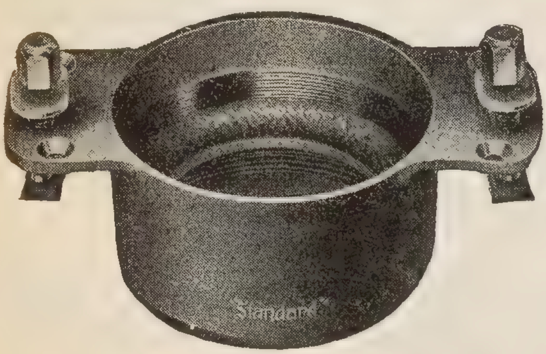
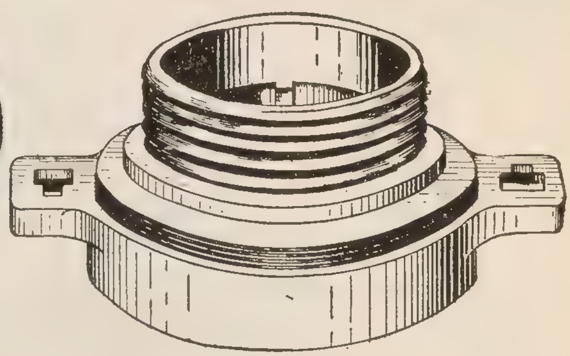
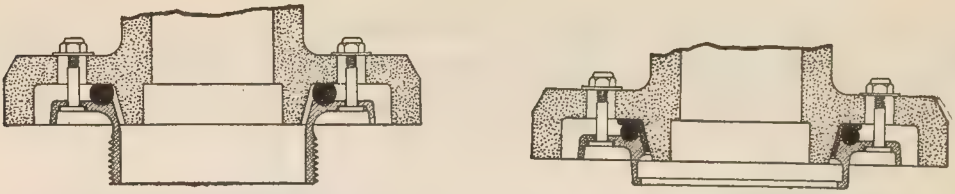


FIG. 7,597.—Standard cast iron closet floor flange (for Universal outlet bowls) with asbestos ring gasket and bolts, ***for caulking into soil pipe.***





FIGS. 7,598 and 7,599.—Standard cast brass closet floor flanges. Fig. 7,598 (for regular or Universal outlet bowls), with adjustable brass ring, asbestos ring gasket and bolts, ***for lead pipe connection;*** fig. 7,599 (for special outlet bowls), ball joint metal to metal with bolts, ***for lead pipe connection.***



FIGS. 7,600 and 7,601.—Standard closet floor flanges. Fig. 7,600, cast brass (for Universal outlet bowls) with asbestos ring gasket and bolts ***threaded 4 in. pipe thread, male;*** fig. 7,601, cast brass (for Universal outlet bowls) with lead and asbestos ring gaskets and bolts; ***for lead pipe connection.***

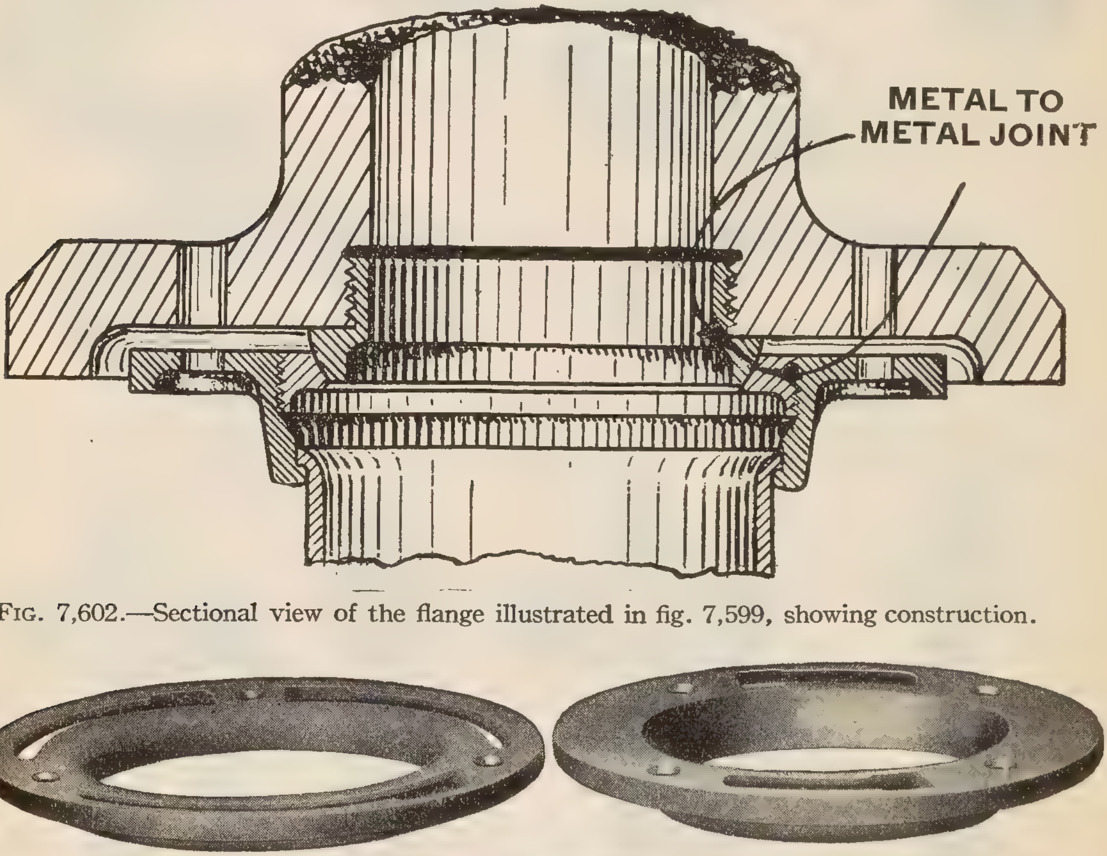
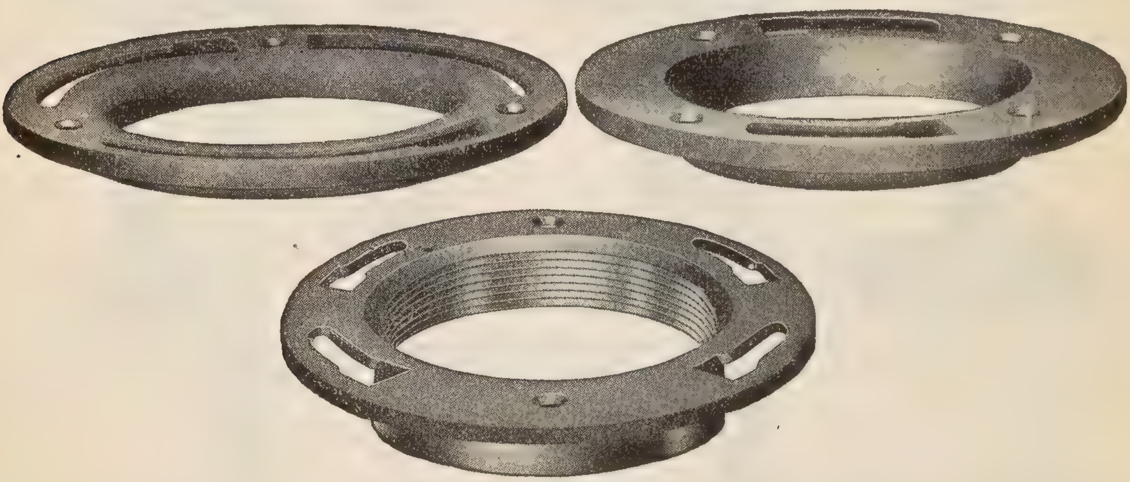


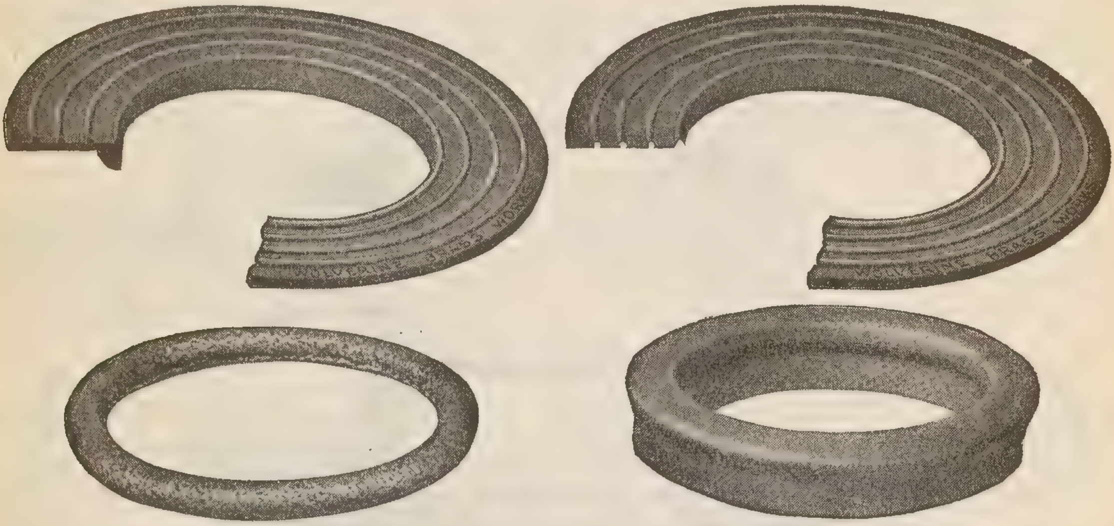
FIG. 7,602.—Sectional view of the flange illustrated in fig. 7,599, showing construction.



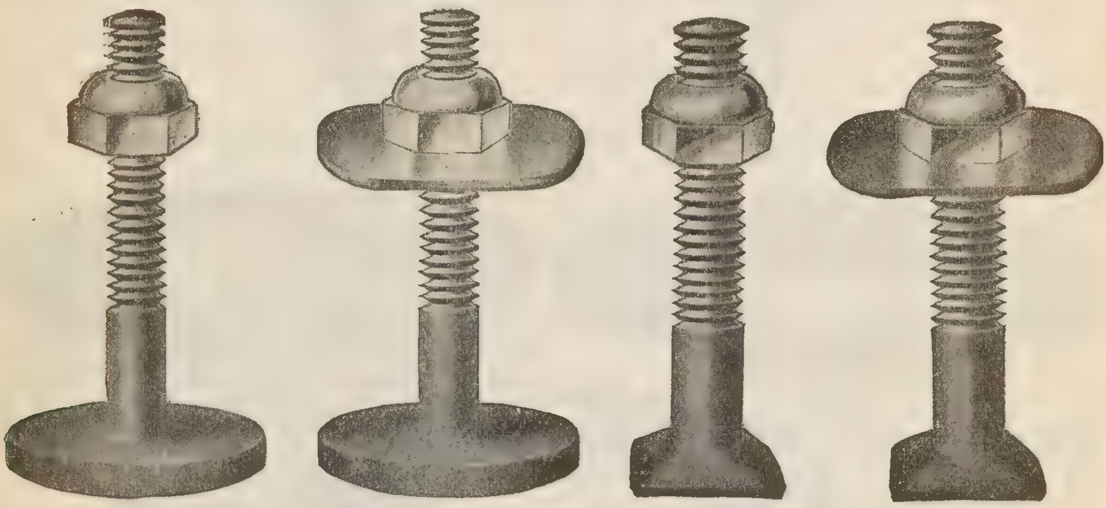
FIGS. 7,603 to 7,605.—Wolverine closet floor flanges. Fig. 7,603, concaved for asbestos ring with ¼ in. lower lip; fig. 7,604, *r.t.* flange for asbestos gasket concaved with 9/16 in. lower lip; fig. 7,605, flange for Durham work, tapped 4 in. pipe thread.

There are several methods of making the water supply or flush pipe connections. The part of the bowl which receives the connection is called the inlet horn and it may be located on the

1. The back.



FIGS. 7,606 to 7,609.—Wolverine floor flange gaskets. Fig. 7,606, Wolverine pattern with lip; fig. 7,607, regular pattern; fig. 7,608, asbestos ring; fig. 7,609, *r.t.* asbestos gasket.

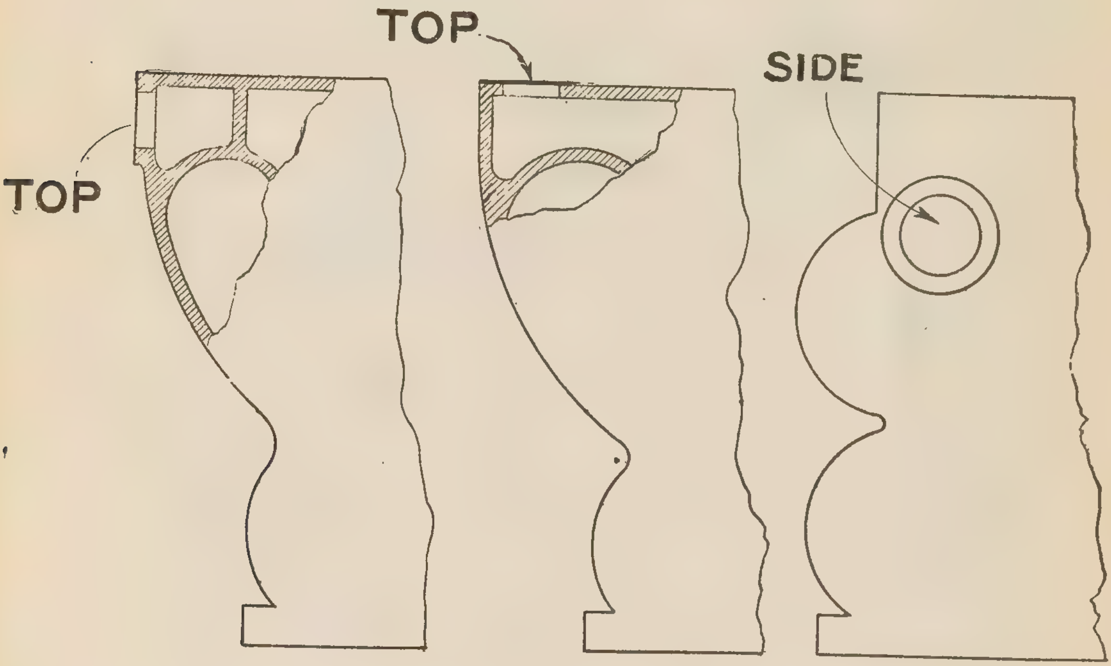


FIGS. 7,610 to 7,613.—Wolverine floor flange bolts. ***Oval base:*** fig. 7,610, bolt only; fig. 7,611, bolt with *n.p.* washer. ***Square tapered base:*** fig. 7,612 bolt only; fig. 7,613, bolt with *n.p.* washer.

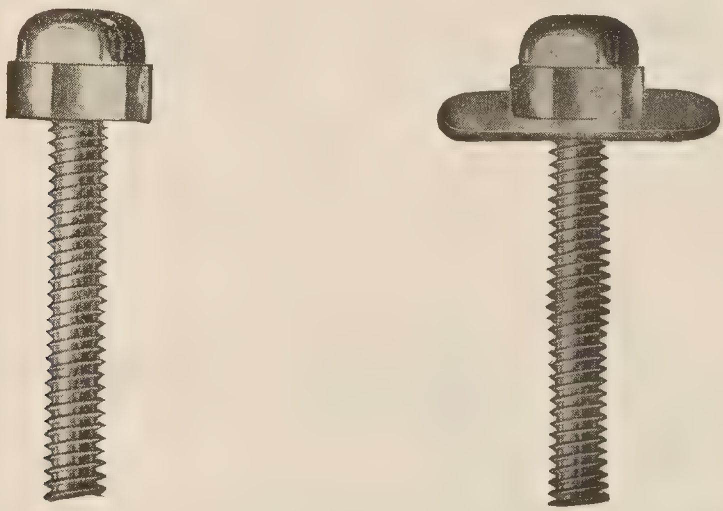
2. Top, or
3. Side.

as shown in figs. 7,614 to 7;616.

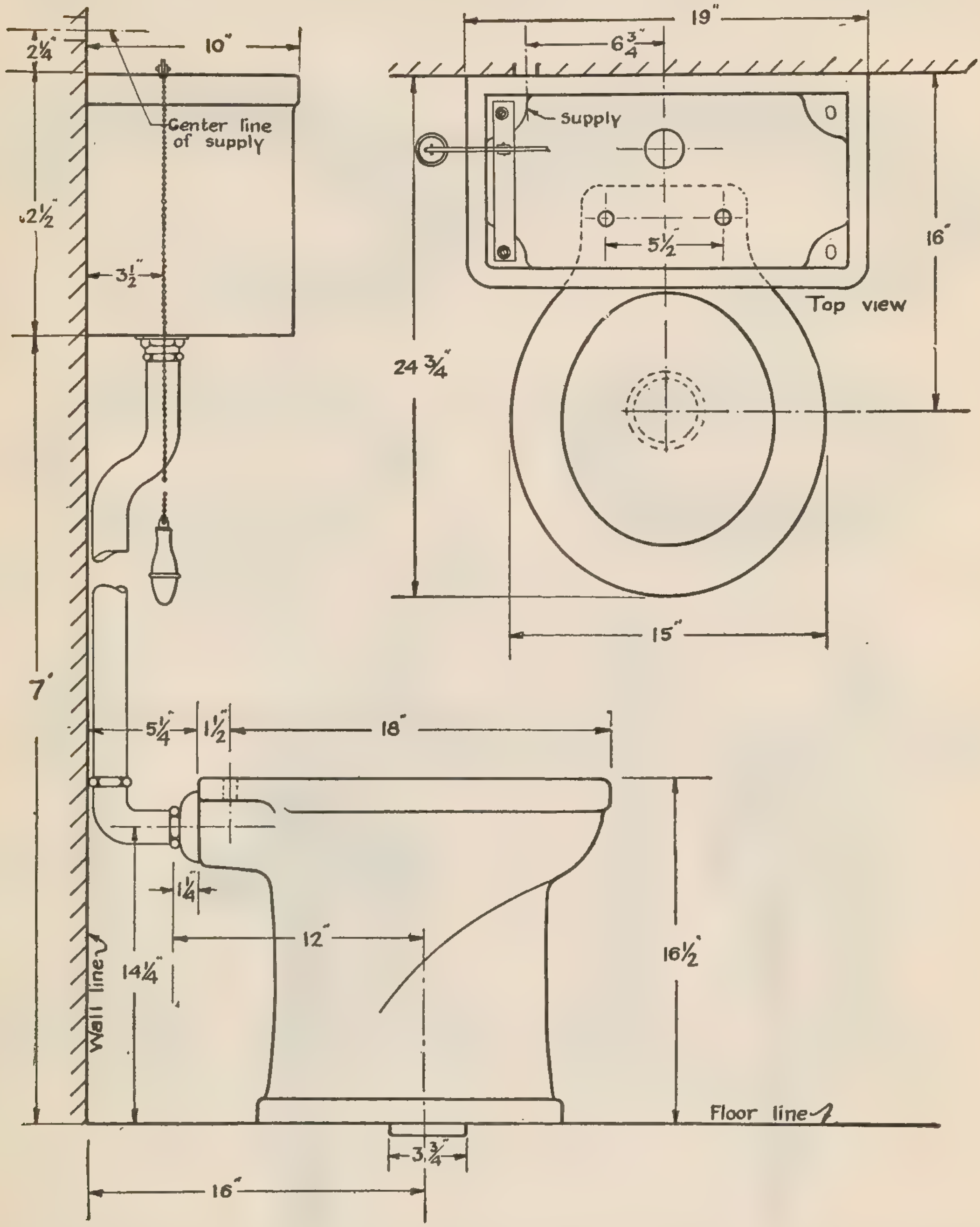
The top connection is largely used especially with low down tanks. The general arrangement of the connections for the three locations of horn is shown in the roughing in measurement drawings, figs. 7,614 to 7,616.



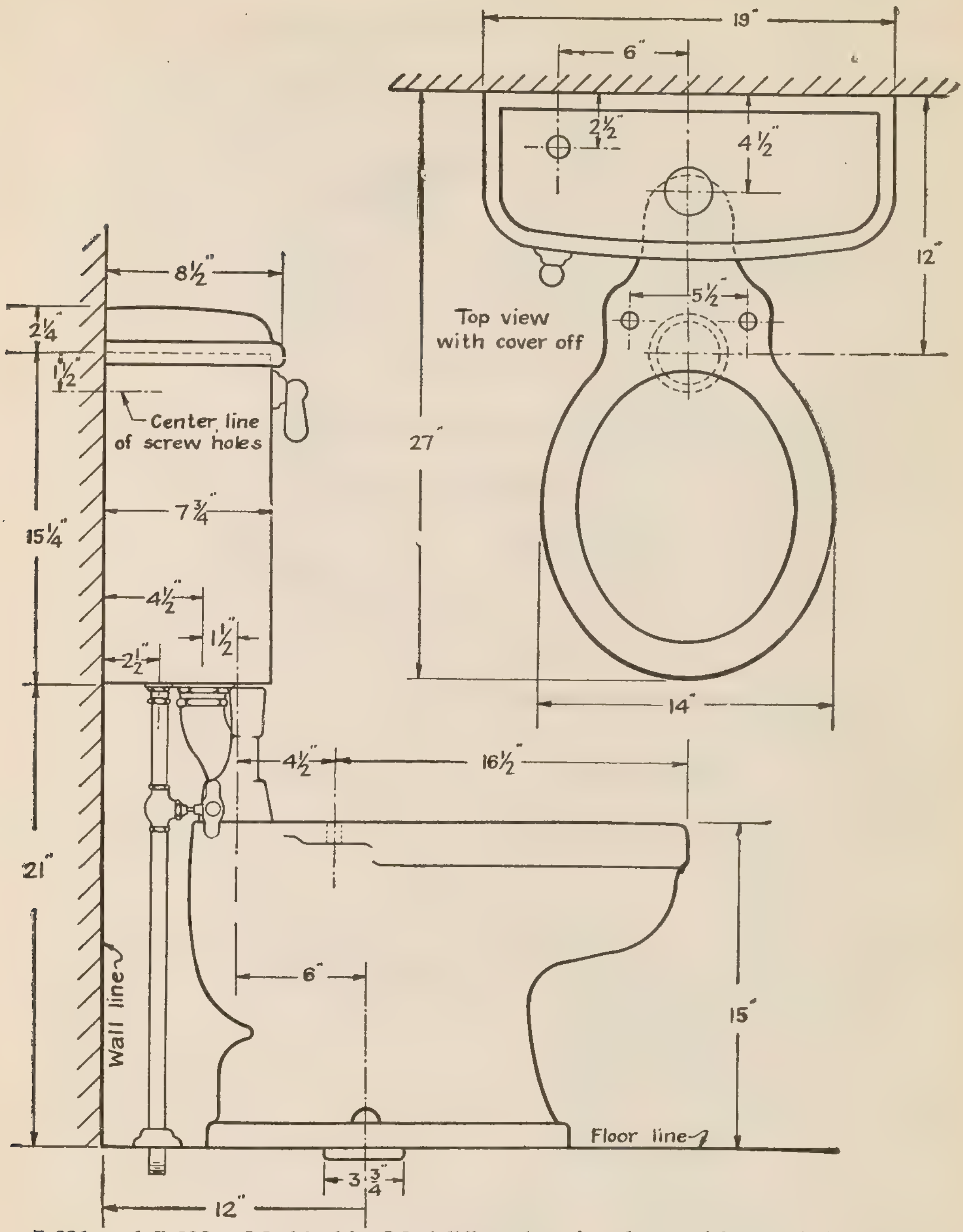
FIGS. 7,614 to 7,616.—Various locations of water inlet or horn connection on water closets. Fig. 7,614, end; fig. 7,615, top; fig. 7,616, side.



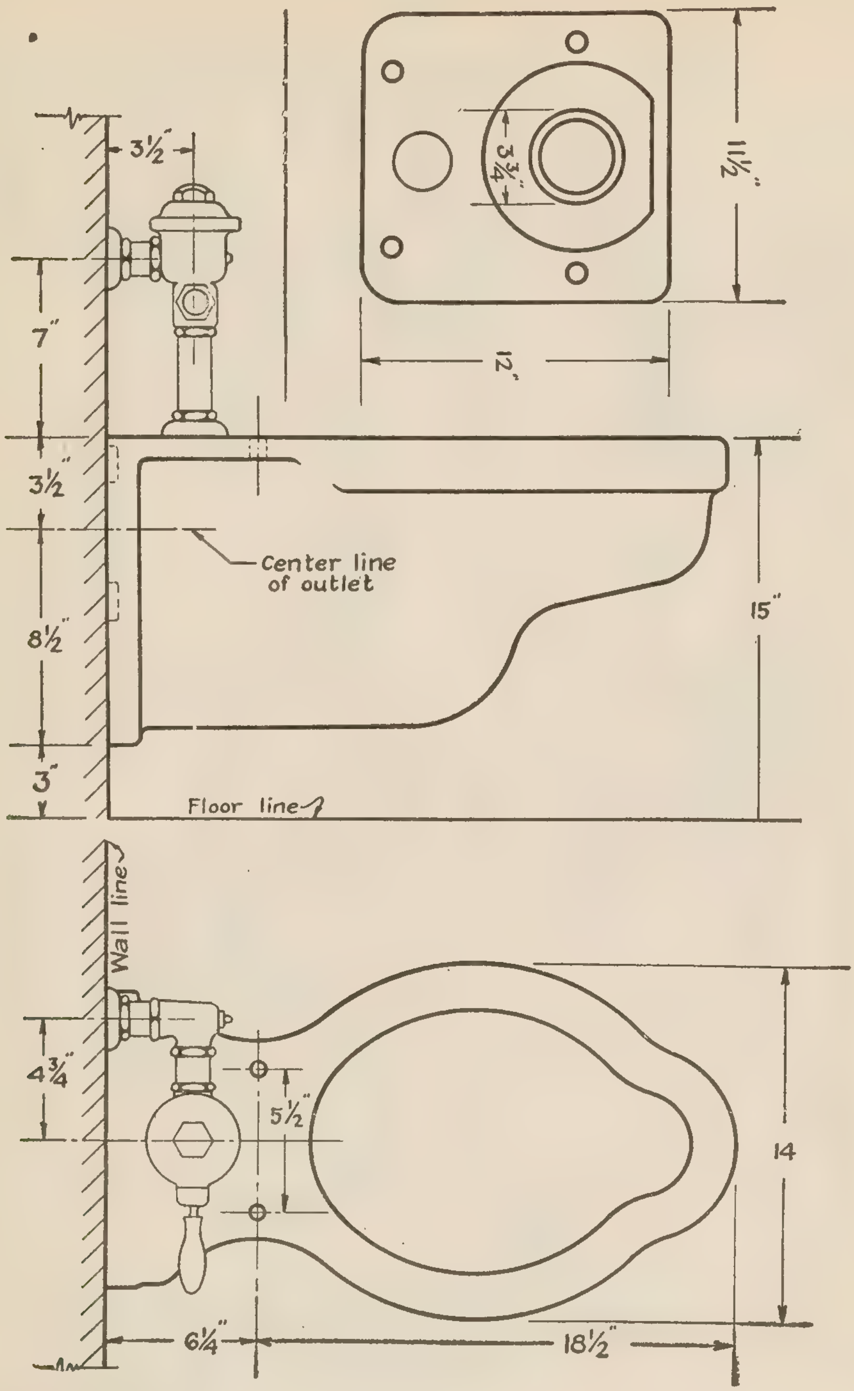
FIGS. 7,617 and 7,618.—Wolverine closet flange bolts ***for tapped flange.*** Fig. 7,617, bolt only; fig. 7,518, bolt with *n.p.* washer.



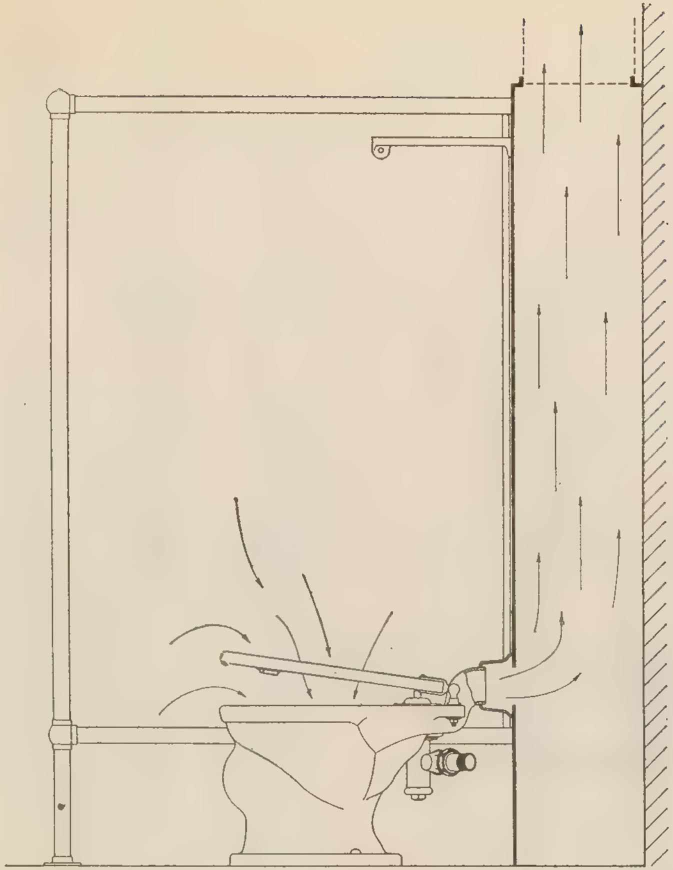
FIGS. 7,619 and 7,620.—Maddock's, Madawan wash down closet with ***back inlet,*** floor outlet and high tank. White vitreous china high tank, fitted with *n.p.* brass flush pipe, *n.p.* brass chain with china handle, heavy brass ball cock and flush valve and *n.p.* brass tank supports.



FIGS. 7,621 and 7,622.—Maddock's, Madcliff syphon jet closet with ***top inlet,*** floor outlet and low down tank. ***Specification:*** white vitreous china syphon jet closet with top inlet, floor outlet and 2 in. brass spud. Height 15 in. opening of bowl 11×13 in. water surface 10×12 ins. and 3 in. water seal. White celluloid covered seat and cover with heavy *n.p.* brass bar hinge. One piece white vitreous china flush pipe cover and white vitreous china bolt caps. The white vitreous china tank is fitted with *n.p.* brass flush connection, top side lever with china handle and escutcheon, heavy brass ball cock, flush valve with large overflow and ⅜ in. *i.p.* size *n.p.* brass supply pipe to floor with china handle stop valve and china floor escutcheon.



FIGS. 7,623 to 7,625.—Maddock's, Madevine wall hanging blow out pattern closet with ***side inlet,*** extended front seat, wall outlet and flush valve. ***Specification:*** white vitreous china wall handing blow-out pattern closet with top inlet wall outlet, extended front lip and 1¼ or 1½ in. brass spud. Opening of bowl 11 × 15 ins. water surface 10×13 ins. and 3 in. water seal. Mahogany finished seat, no cover. Flush valve with china oscillating handle.



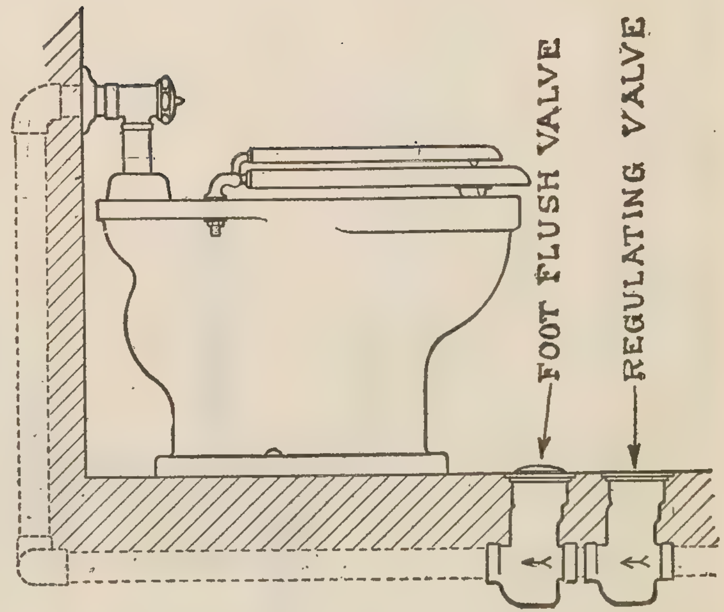


FIG. 7,626.—Mott, Attila combination wash down syphon closet with Boston vent, raised back inlet, flow outlet showing by arrows ventilation current. The ventilating chamber is closed at the top, extends to the floor and has a door at the end for cleaning purposes. The ventilating chamber should be connected with vent flue. This vent flue should have some means of maintaining continuous upward or outward draught so as to constantly draw air through the "Boston" vent.

FIG. 7,627.—Top connected water closet equipped with Mott slow closing foot action flush valve and regulating valve concealed in flow with white metal plates.

Bidet.—This fixture (pronounced be-day′) is an important sanitary fixture which has not been used extensively in this country due to the lack of knowledge of its health protecting features. For years it has been in common use in Europe and all Latin-American countries. Through ignorance of its advantages many regard the bidet as a fixture to be used for birth control. This is obviously incorrect because a plain water douche cannot accomplish this purpose.

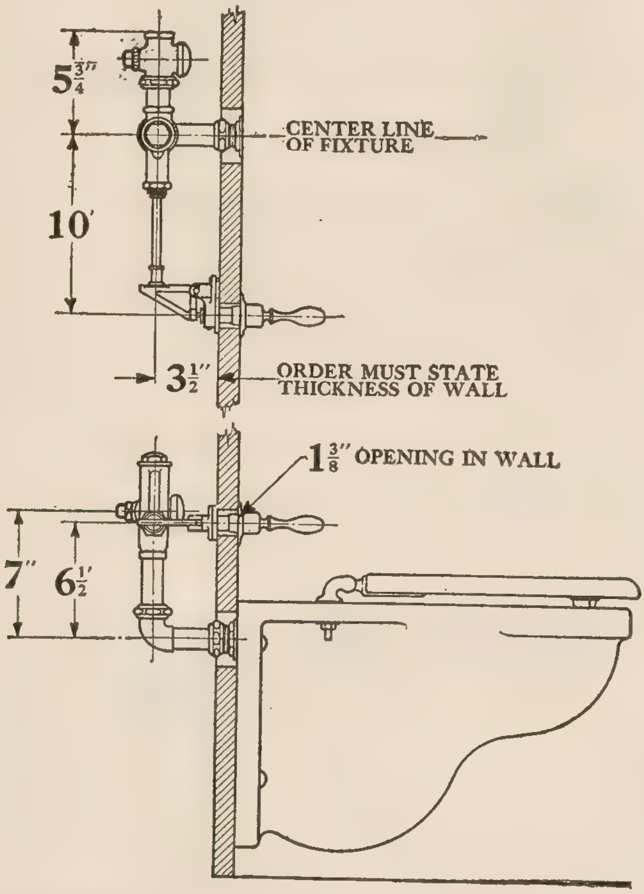


FIG. 7,628.—Wall hanging closet with roughing in measurement for top connected Oscilla flush valve.

The bidet fixture is an appliance to maintain for the user a constant state of cleanliness of the private parts.

It is preferably made entirely of white vitreous china is about 14 ins. in width and 15 ins. high from the top of the rim to the floor.

It is equipped with hot and cold supply valves and a pop up waste to retain water in the bowl or to drain it when desired. The inside walls of the bowl are washed by a flushing rim on the same principle as the water-closet, although the bidet is not designed nor intended to carry off human waste matter.

The bidet is also provided with an integral douche or jet, operated when desired by means of a transfer valve which directs a stream or column of water upward from the bottom of the bowl.

This douche is formed by a cluster of small holes so arranged as to direct the water to one central point, thereby forming a solid stream. In the earlier models of bidets the douche was made of brass in the form of a nozzle to which a rubber tube with a syringe appliance might be attached for women's use. The use of the bidet as a syringe was a dangerous practice, however, as uniform temperature of the water could not be assured while the douche was in use. Turning on the cold water in another part of the house was likely to raise the temperature of the douche, and burning or scalding sometimes resulted.

The brass nozzle douche was also objectionable because the user would strike it with the fingers while washing.

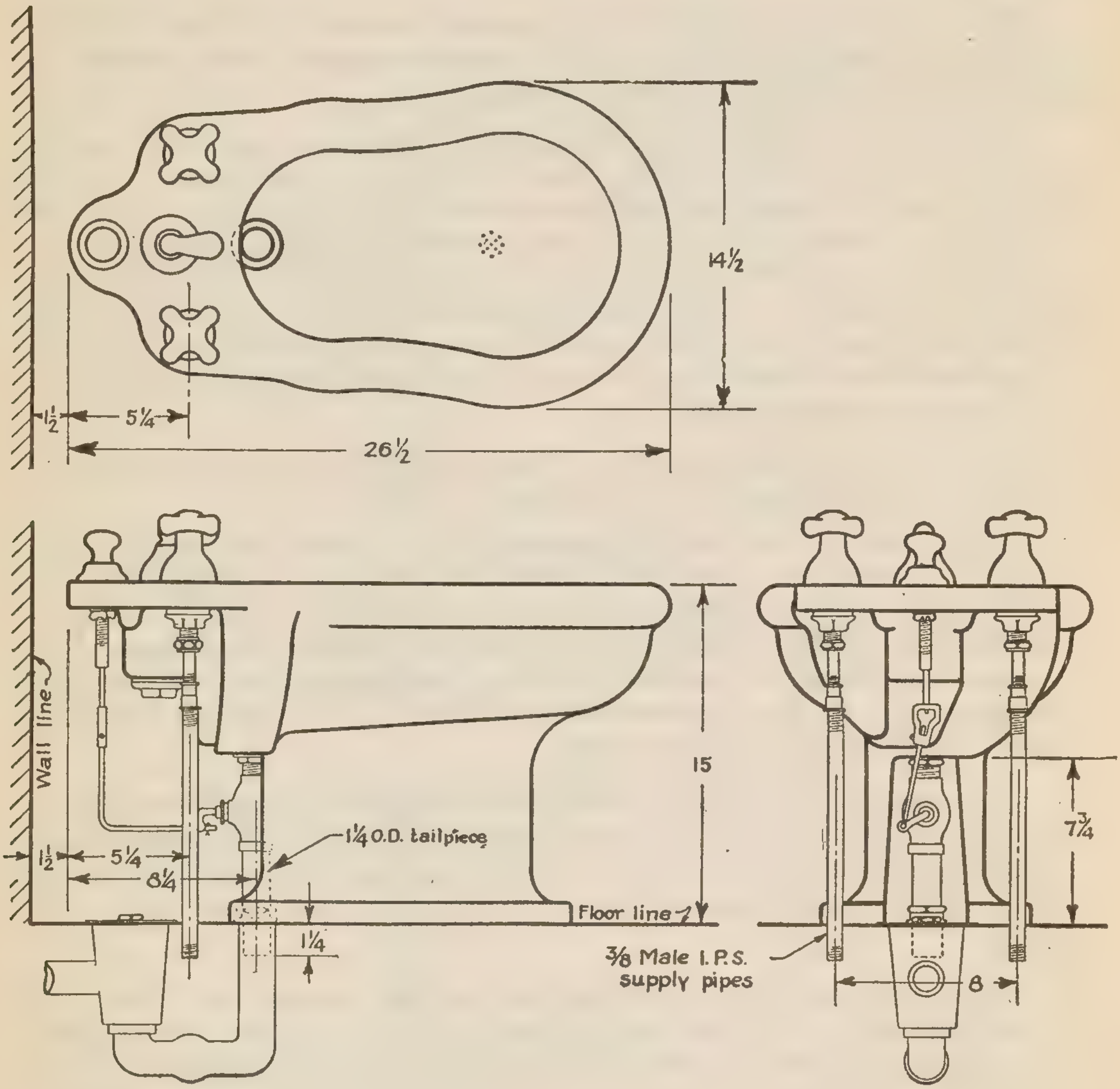
After a bowel movement it is impossible to cleanse the anus with dry paper. This practice, the medical fraternity tells us, is responsible for a large proportion of the existing cases of hemorrhoids or piles. The use of the bidet does much to eliminate the possibility of developing hemmorrhoids or piles, and is also recommended for their treatment. After each passage, the anus actually should be washed with water. (The bidet is usually installed alongside of the water closet).

With women, the bidet should be an indispensable bath room fixture, because proper attention to health requires bathing of the genital organs more frequently than can be accomplished conveniently with the bath tub. It is essential and conducive to good health to wash these parts twice daily.

This use for the bidet is also essential for men, because the ordinary tub or shower bath is not sufficient to secure a similar degree of cleanliness. As with women, men too should bathe these parts twice each day.

Women will find the bidet a very important and convenient fixture for use during their menstruating period. The genital organs should always be thoroughly cleansed when changing the sanitary pad, and the bidet is the proper fixture for this use. The bidet is particularly desirable in manufacturing plants where a number of women are employed or in department stores, women's colleges and other institutions.

Another important use of the bidet is that of a foot bath. As it is 15 inches high from the floor to the top of the rim, it can be used very comfortably as a foot bath. When the waste plug is closed the bidet will hold about 3 inches of water. There will be no hesitancy about using the bidet



Figs. 7,629 to 7,631.—Maddock's bidet; views showing roughing in measurements and connections.

as a foot bath after it has been used for bathing other parts because, being made of pure white vitreous china and having a flushing rim, it can be kept spotlessly clean and sanitary by simply rinsing with water or wiping with a damp cloth. It cannot tarnish or discolor.

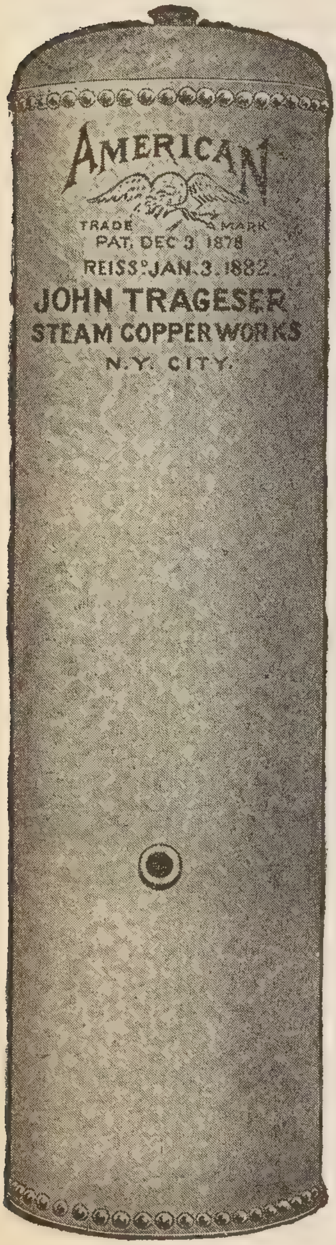
The private parts may be washed by the bidet with or without the use of the douche. By closing the pop up waste the bowl may be filled and the washing done with the hand. After this the parts may be rinsed by using the douche. If preferred the entire washing may be done with the douche.

In using the bidet it is not necessary to undress. The clothing is in the same position as when using the water closet.

The use of the bidet is a clean habit and when once acquired it becomes an important part of the sanitary precuations of our daily life. Its importance in promoting better health can hardly be overestimated. The method of making the connection for bidets is illustrated in figs. 7,629 to 7,631.

Hot Water Storage Tank.—The error of calling this fixture a "boiler" is inexcusable, and it would require a stretch of the imagination to consider it as such.

The ordinary kitchen, or range storage tank is made in a multiplicity of sizes so that there is a wide choice of capacity enabling selection to be made that will meet the requirements of any proposed installation. The range of ordinary sizes is given in the following table.



NOTE.—*A copper tank* flattened by accidental syphonage will sometimes round up again under the water pressure without apparent damage. If the city pressure do not inflate it, a force pump will.

NOTE.—*Galvanized tanks* are made in several weights known as: standard, extra heavy, double extra heavy, etc., the choice depending upon the pressure. Light weight tanks are so cheap that it does not pay to try to repair them. The stock is too thin to weld well, the skin of galvanizing cannot be soldered tight and the work of getting down to the iron is too expensive, considering that a new break may soon develop.

FIG. 7,632.—Trageser galvanized vertical storage tank made in three grades: standard, X heavy, XX heavy. *Sizes:* 12×36 to 24×96, 18 to 192 gals.

Sizes of Range Storage Tanks

Approximate Capacity Gallons	Diameter, Inside, of Shell Inches	Length of Shell Feet
18	12	3
21	12	3½
24	12	4
24	14	3
27	12	4½
28	14	3½
30	12	5
32	14	4
36	14	4½
40	14	5
42	16	4
47	16	4½
52	16	5
53	18	4
66	18	5
82	20	5
100	22	5
120	24	5
144	24	6
168	24	7
192	24	8

The theoretical points on storage tanks have been entirely covered in the chapter on Water Supply (which see). Storage tanks are made of galvanized iron or steel, and of copper.

There are two general types.

1. Vertical.
2. Horizontal.

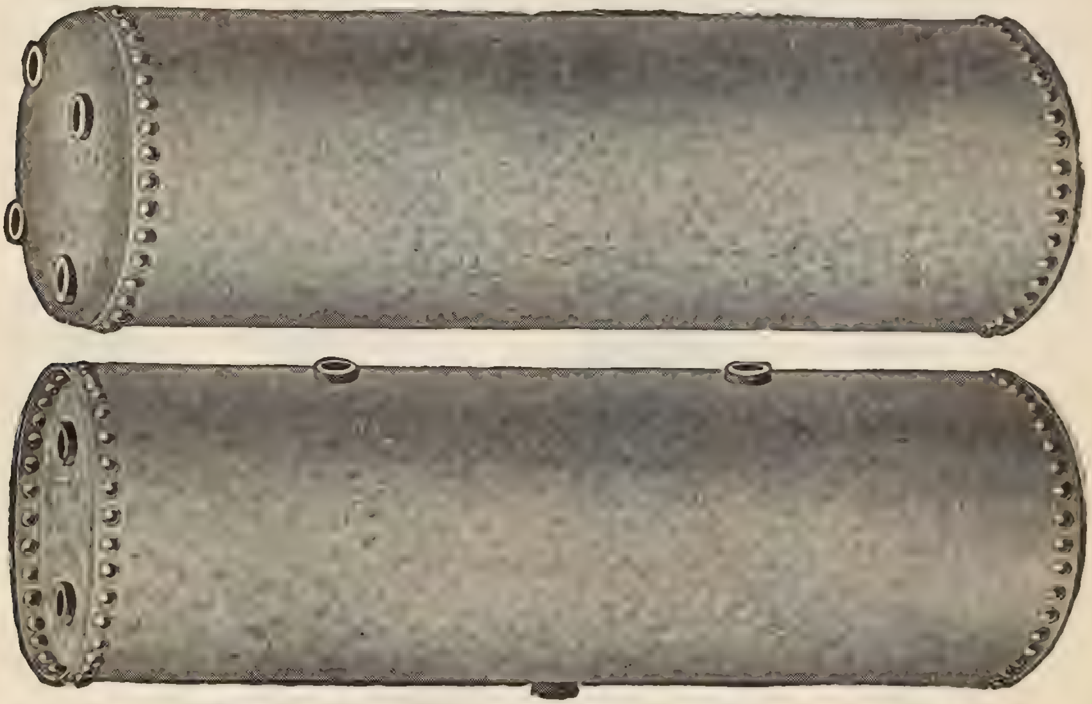
These differ principally in the location of the openings for pipe connections.

The methods of heating the water by

1. Water back in range.
2. Steam coil in tank.
3. Furnace in tank.

The latter type is a combination of storage tank and water heater, being known as a water heater.

The galvanized iron or steel tank is made single riveted for light pressures and double riveted for heavy pressures being known as standard and extra heavy. Tanks regularly have four openings; if additional openings be desired an extra charge is made. Usually on tanks 12, 14 and 16 ins. diameter all couplings are threaded ¾ in. pipe thread, although couplings threaded ½ in. pipe thread or ¾ and ⅞ in. fine thread female may be ob-

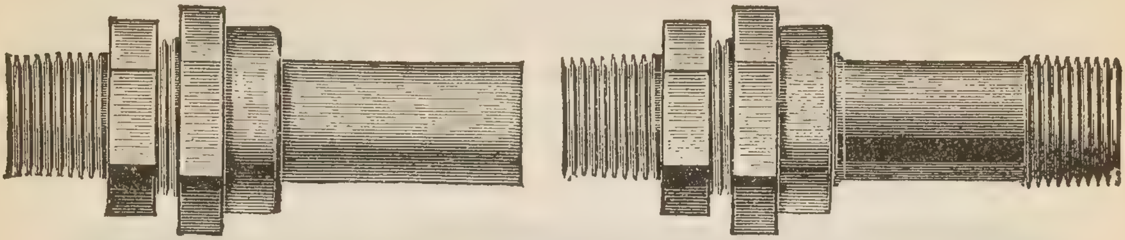


FIGS. 7,633 and 7,634.—Trageser galvanized horizontal storage tanks. Fig. 7,633, convex heads; fig. 7,634, concave heads. In ordering horizontal tanks position and size of tappings should be given.

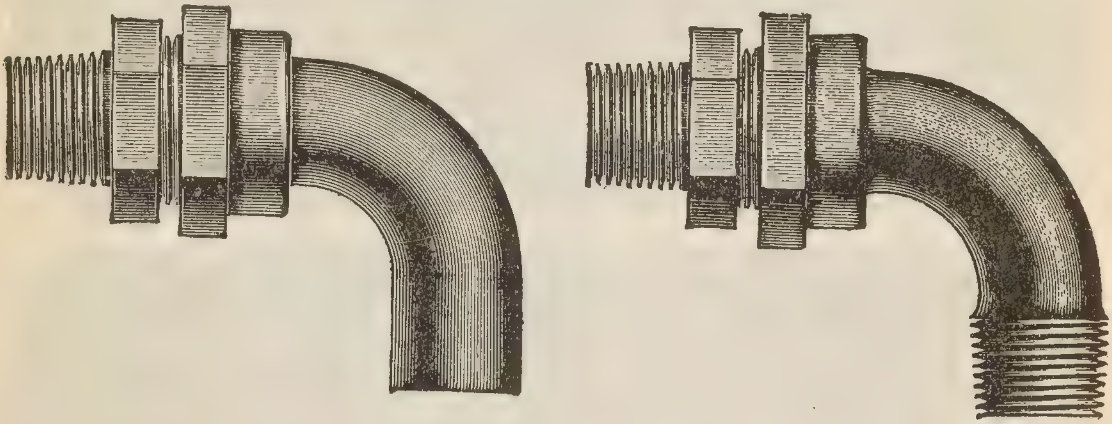
tained. On tanks 20 and 24 ins. diameter all couplings are regularly threaded 1 in. pipe thread male. These are union couplings, some four of which are shown in figs. 7,635 to 7,638 and are used in order that the tank may be disconnected (for cleaning or repairs) without disturbing the pipes.

The cold water supply should enter through one of the top openings and pass down through the boiler to a point about 3 ins. above the level of the range water back and below the side coupling.

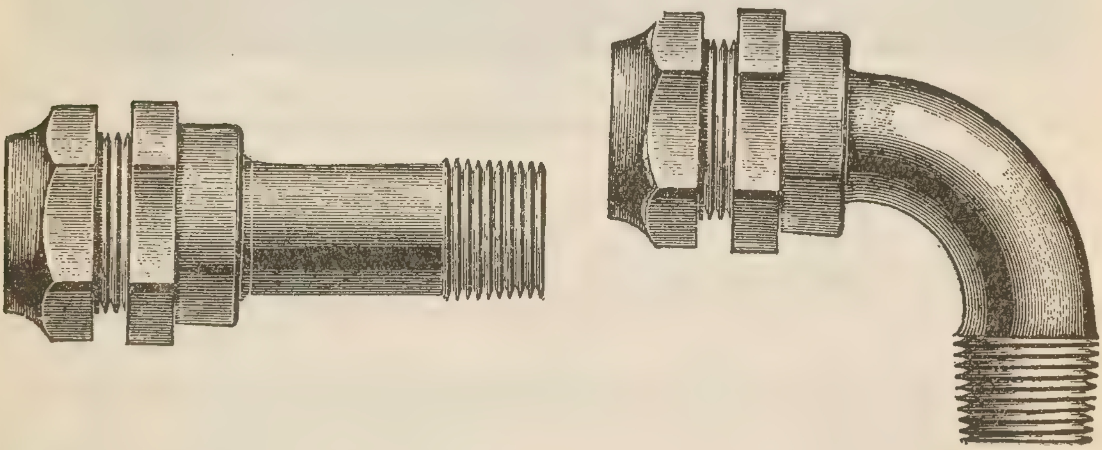
This is accomplished by an internal tube such as is shown in fig. 7,646. The cold water supply should be provided with a gate valve, so that the supply can be shut off in case of repairs.



FIGS. 7,635 and 7,636.—Standard brass storage tank couplings. Fig. 7,635, for lead pipe; fig. 7,636, for wrought pipe, male.



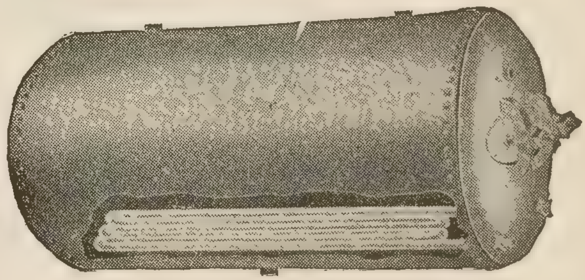
FIGS. 7,637 and 7,638.—Bent brass storage tank couplings. Fig. 7,637, for lead pipe; fig. 7,638, for wrought pipe, male.



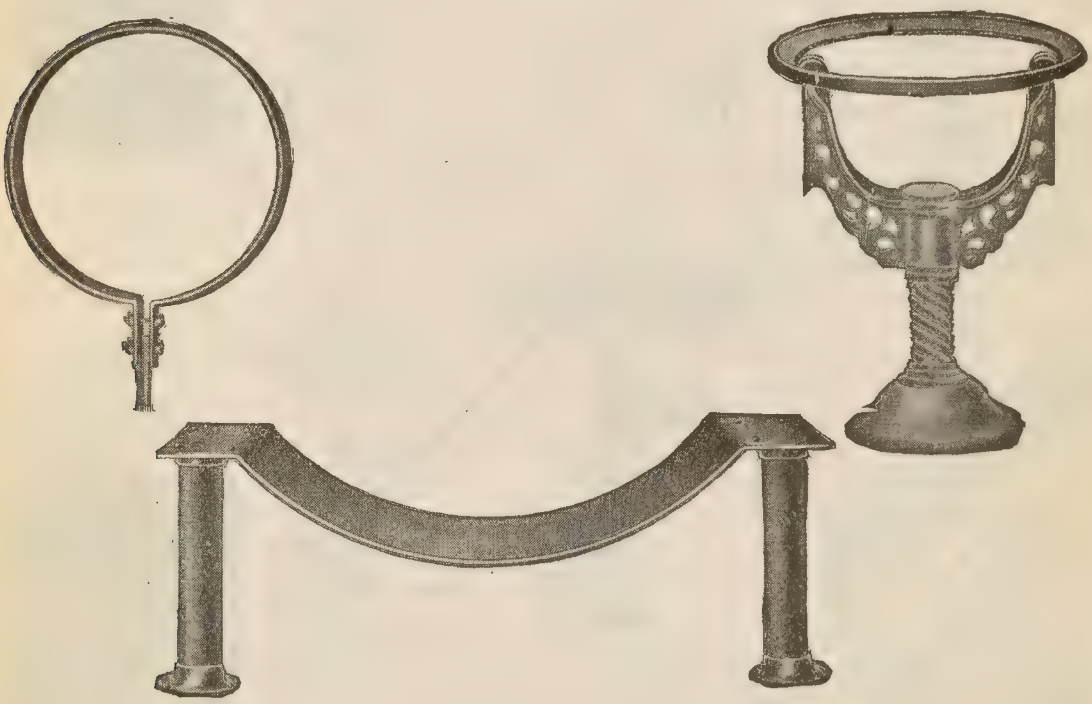
FIGS. 7,639 and 7,640.—Water back couplings. Fig. 7,639, straight; fig. 7,640, bent. These couplings as shown have male wrought thread but are also made with plain ends for wiped joint lead pipe connection.

Vertical tanks are set upon stands about 20 ins. high. Horizontal tanks are hung by straps from the ceiling or supported on brackets.

In connecting storage tanks, the top hole in the water back should be connected to the side opening in the tank. The bottom hold in the water back should be connected to the lower opening in the tank. It is necessary and



FIGS. 7,641 and 7,642.—Trageser galvanized extra heavy storage tanks with coil. Fig. 7,641, vertical; fig. 7,642, horizontal.



FIGS. 7,643 to 7,645.—Trageser storage tank supports. Fig. 7,643, hanger; fig. 7,644, stand; fig. 7,645, saddle.

important that a union connection be placed on these pipes so that the tank may be taken down without disturbing the range.

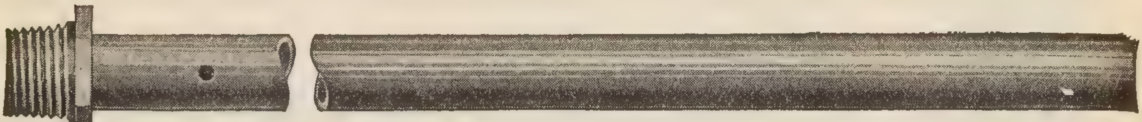


FIG. 7,646.—Wolverine 5/8 in. outside diameter internal brass tube for storage tank. Threaded ½ in. wrought pipe thread; length 51 ins.; vent hole ⅛ in.

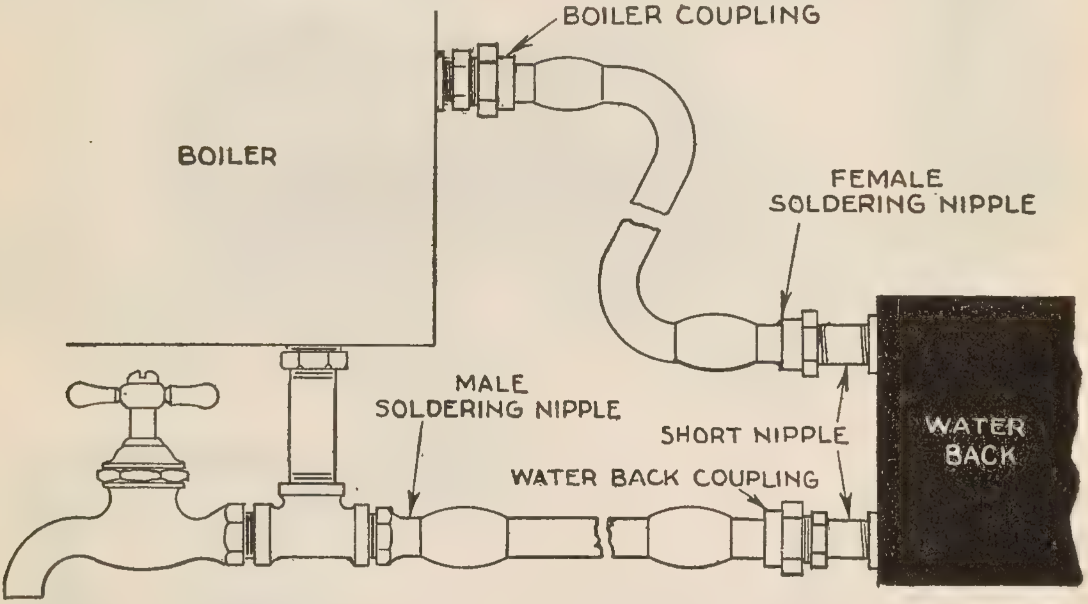


FIG. 7,647.—Lead pipe connections between tank and water back.

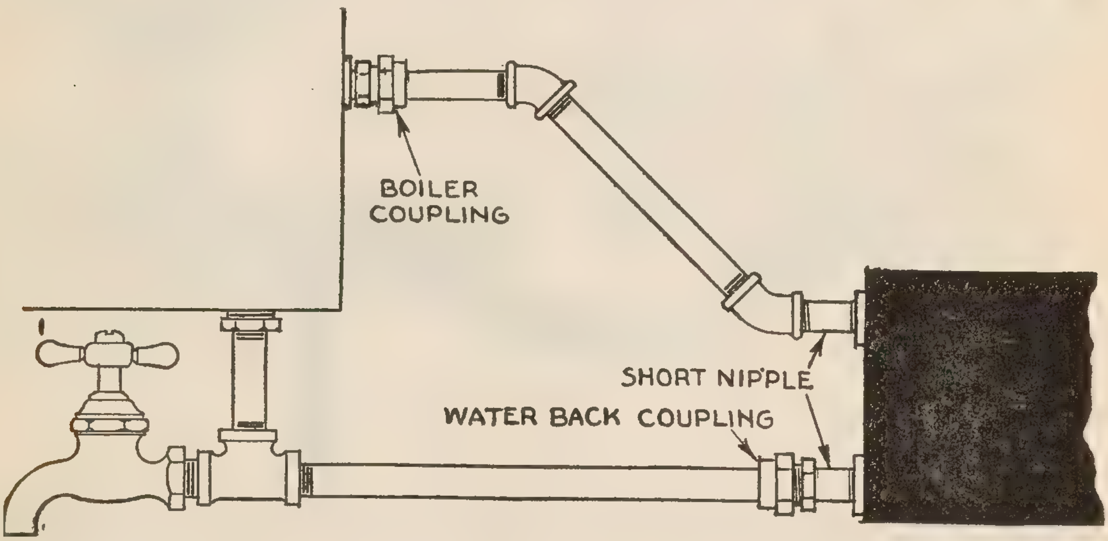


FIG. 7,648.—Wrought pipe connections between tank and water back.

A faucet should be connected to the lower pipe to drain the tank. Bends and changes should be avoided as much as possible. These pipes may either be galvanized, wrought, lead, or preferably brass. Wrought pipe does not sag, however it will corrode and gradually fill, especially at the ends which join the fittings.

Lead allows easy curves and changes in direction to be made; it, however,

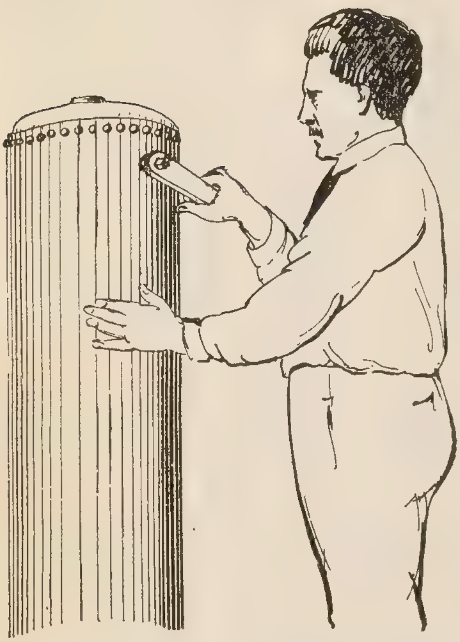
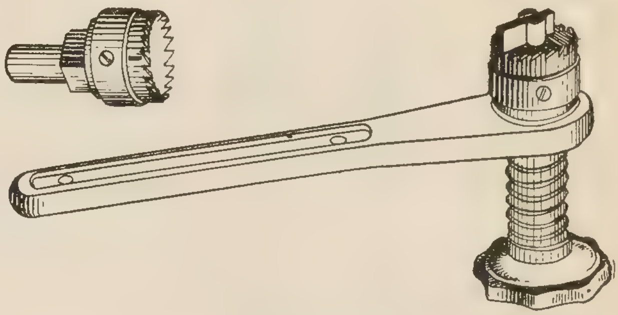
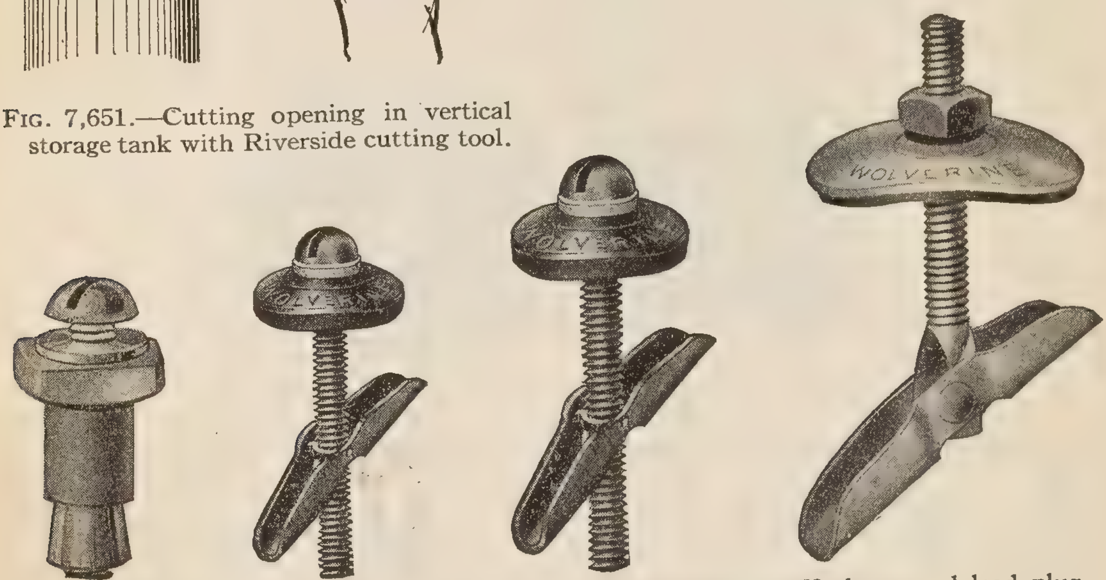


Fig. 7,651.—Cutting opening in vertical storage tank with Riverside cutting tool.



Figs. 7,649 to 7,650.—Riverside ratchet cutting tool and view of cutter.



Figs. 7,652 to 7,655.—Wolverine storage tank repairs. Fig. 7,652, brass and lead plug—drill $\frac{5}{16}$ hole and make up with screw driver; fig. 7,653, small toggle, screw $\frac{1}{8}$, plate $\frac{5}{8}$; fig. 7,654, medium toggle, screw $\frac{3}{16}$, plate 1; fig. 7,655, large toggle, screw $\frac{1}{4}$, plate $1\frac{3}{4}$ in. All top plates are concaved to conform to curve of boiler and are furnished with special rubber gaskets for hot water and steam.

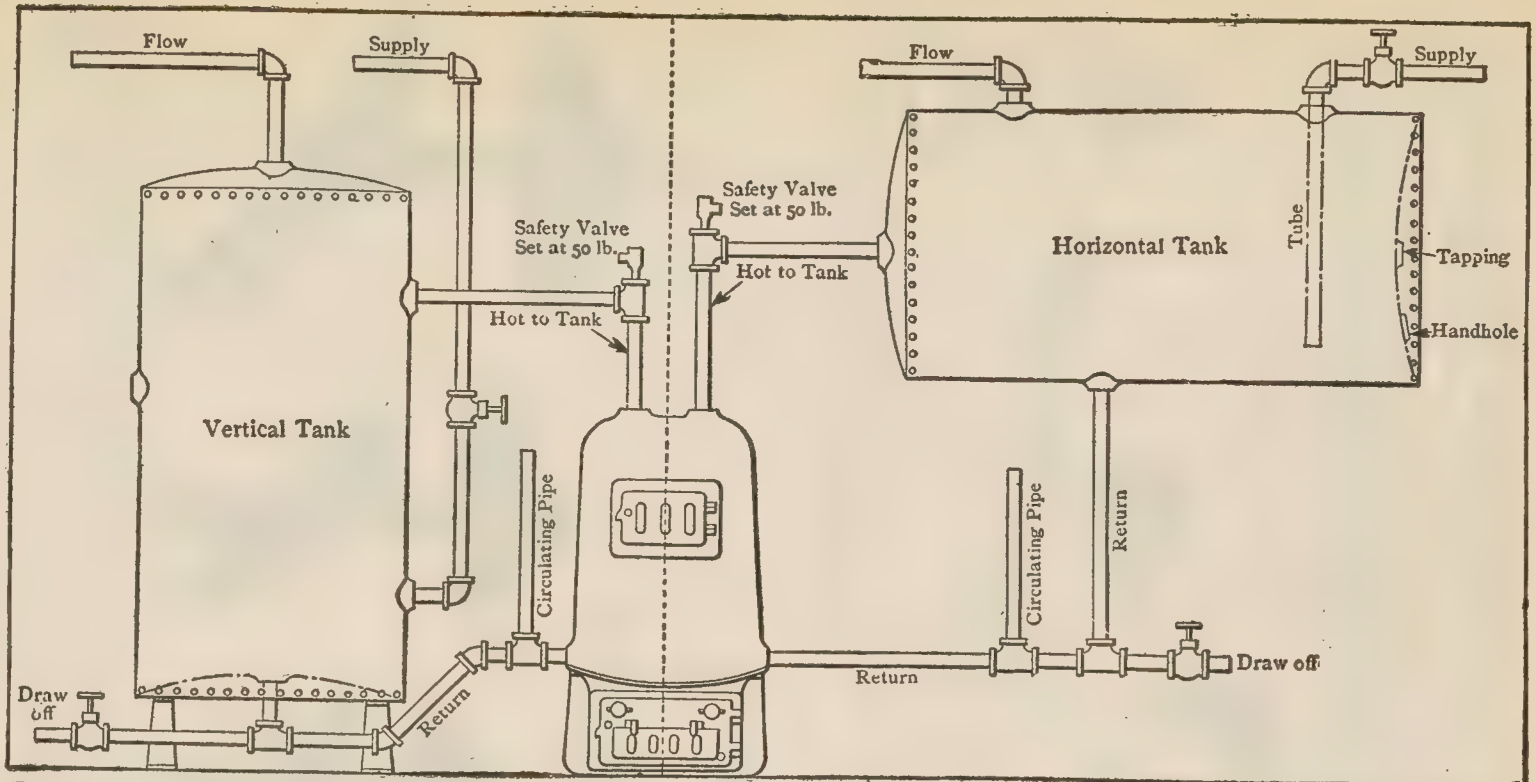


FIG. 7,656.—Methods of connecting vertical and horizontal storage tanks to hot water heater. The illustration does not show the usual couplings connecting lines to the tanks.

NOTE.—***In apartment, or other houses*** where steam pressure is constantly maintained, the whole plumbing system is usually supplied with hot water through the medium of a reservoir provided with steam coil of iron, brass, or copper pipe. The *trombone* type coil, made of several pipes of equal length and joined "in series" by return bends, can be used only on horizontal tanks; it would not drain in any other position. The condensed steam is wasted into the sewer, delivered to a hot well, or returned to boiler by steam trap.

NOTE.—***The efficiency of a steam coil*** when surrounded by water is much greater than when placed in the air. An iron pipe will give off about 200 thermal units per square foot of surface per hour for each degree difference in temperature between the steam and the surrounding water. This is assuming that the water is circulating through the heater so that it moves over the coil at a moderate velocity. The condensing power of galvanized pipe is very nearly the same as that of plain iron, the coating being an alloy and not pure zinc as is generally supposed.

sags, stretches and the wiped joints give out under the continued action of hot water. Brass pipe and fittings are excellent. Lead connections are generally ⅝ or ¾ in. Wrought pipe connections are generally ¾ or 1 in.

Figs. 7,647 and 7,648 show method of making water back connection with lead and wrought pipe. The hot and cold supply connection are shown in fig. 7,657.

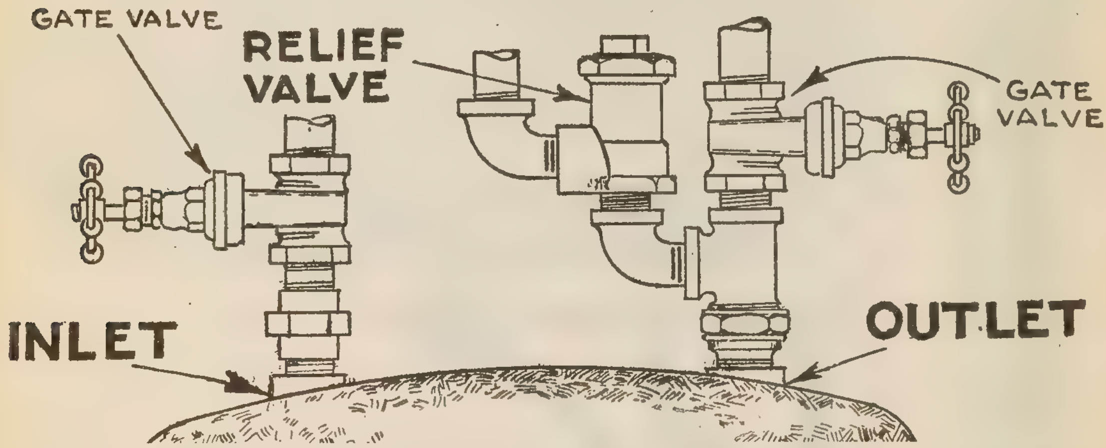
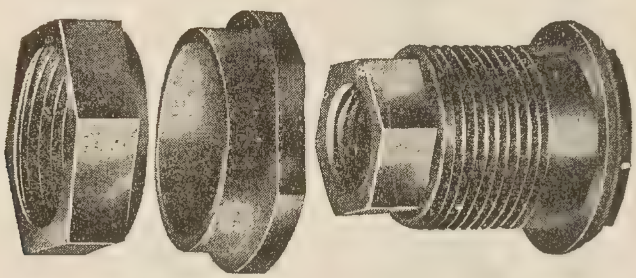


FIG. 7,657.—Hot and cold water tank connections with provision for shut off in case of repairs and excess pressure relief.



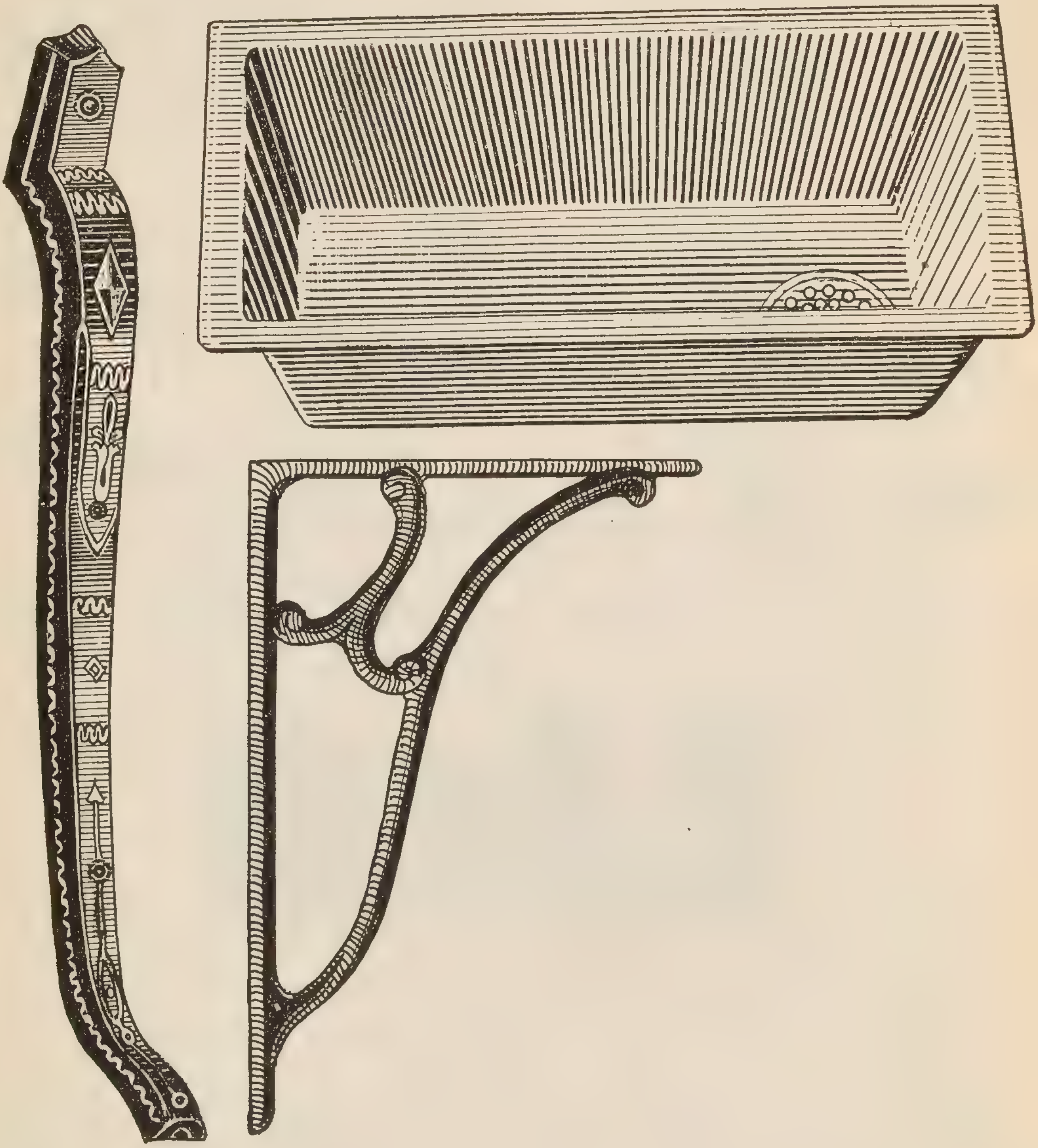
FIGS. 7,658 to 7,660.—Riverside storage tank connection.

The globe valve will be found very convenient in case of repairs.

When a valve is placed on the cold water supply, there should be a safety valve to relieve any excess pressures in case this

NOTE.—A 30 or 40 gallon boiler is usually specified for an 8 or 10 room house.

valve should be closed without opening a hot water faucet. Note that this valve is next to the tank.



FIGS. 7,661 to 7,663.—Plumbers square cast iron sink and Bignall fittings for cast iron sinks. Fig. 7,661 cast iron sink; fig. 7,662 leg; 7,663 bracket. ***Range of sink sizes*** is from 12 × 12 to 24 × 120 ins., all sizes 6 ins. deep. Legs come in lengths to raise sink 27 to 30 ins. from floor.

Sink.—The kind of sink as shown in fig. 7,661, that is almost universally used on cheap work is made of cast iron. Being non-absorbent, has a long life and is cheap. They, however, will corrode. The rim is generally covered with wood which affords a lodging place for dirt, filth, and vermin. It is

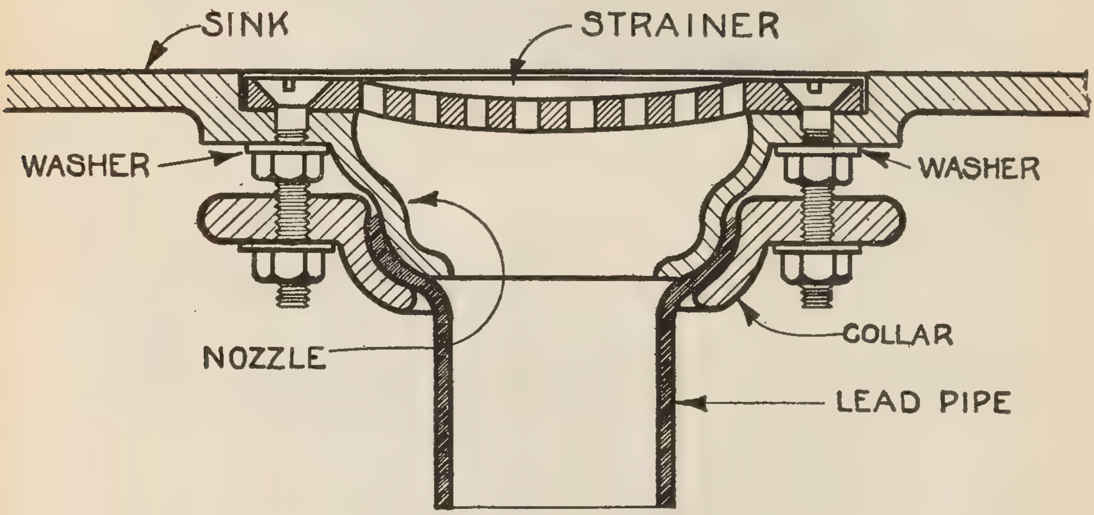


FIG. 7,664.—Cast iron sink waste connection for lead pipe.

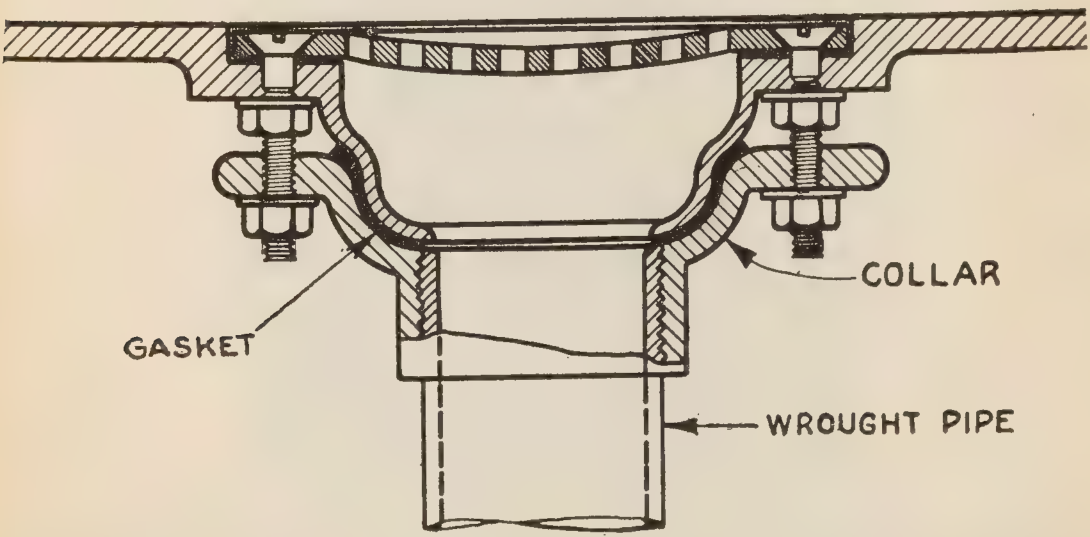


FIG. 7,665.—Cast iron sink waste connection for wrought pipe. note the rubber gasket and threaded collar.

FIG. 7,666.—Mott, Belgrade, enameled iron roll rim ***kitchen sink*** with integral back and right hand drain board, concealed wall hangers, waste plug with strainer and tail piece, compression faucets, half S trap with nipple to wall and escutcheon and two wood mats for sink and drain board.

FIG. 7,667.—Mott, Touro, enameled iron ***slop sink*** with brass flushing rim painted iron combination trap standard with strainer, Oscilla flush valve and angle stop and $1\frac{1}{4}$ in. *o. d.* tubing flush connection. Combination compression faucet with integral stop valves and pail hook and brace with flush pipe clamp.

difficult to make a proper connection with the trap and waste pipe. These sinks are sometimes made with a roll rim which makes it unnecessary to protect the edge with wood. Figs. 7,664 and 7,665 show methods of making waste connection of cast iron sinks for lead and wrought pipe respectively. Views of the two forms of collar used are shown in figs. 7,677 and 7,678

FIGS. 7,668 and 7,669.—Mott slop sink traps. Fig. 7,668, three in. painted iron combination trap standard, enameled inside, with strainer and clean out plug for lead pipe; fig. 7,669, three in. *Adjusto* painted iron combination trap standard, enameled inside, with strainer and clean out plug for 3 in. wrought pipe.

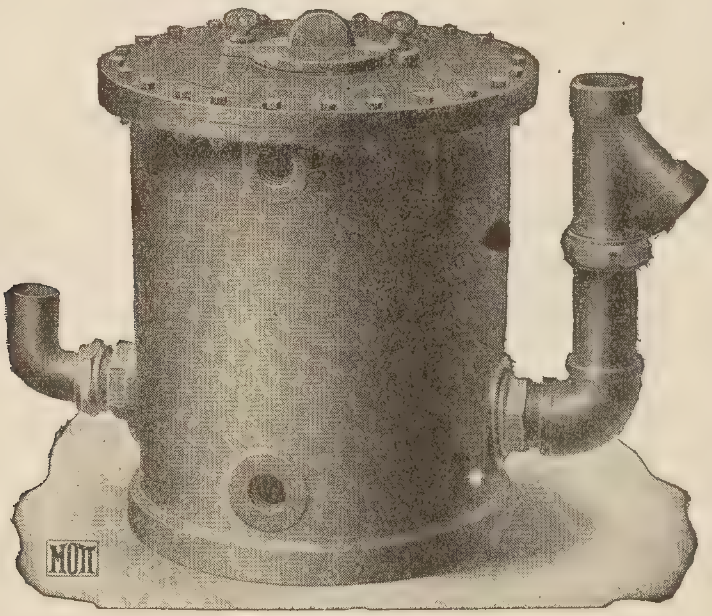
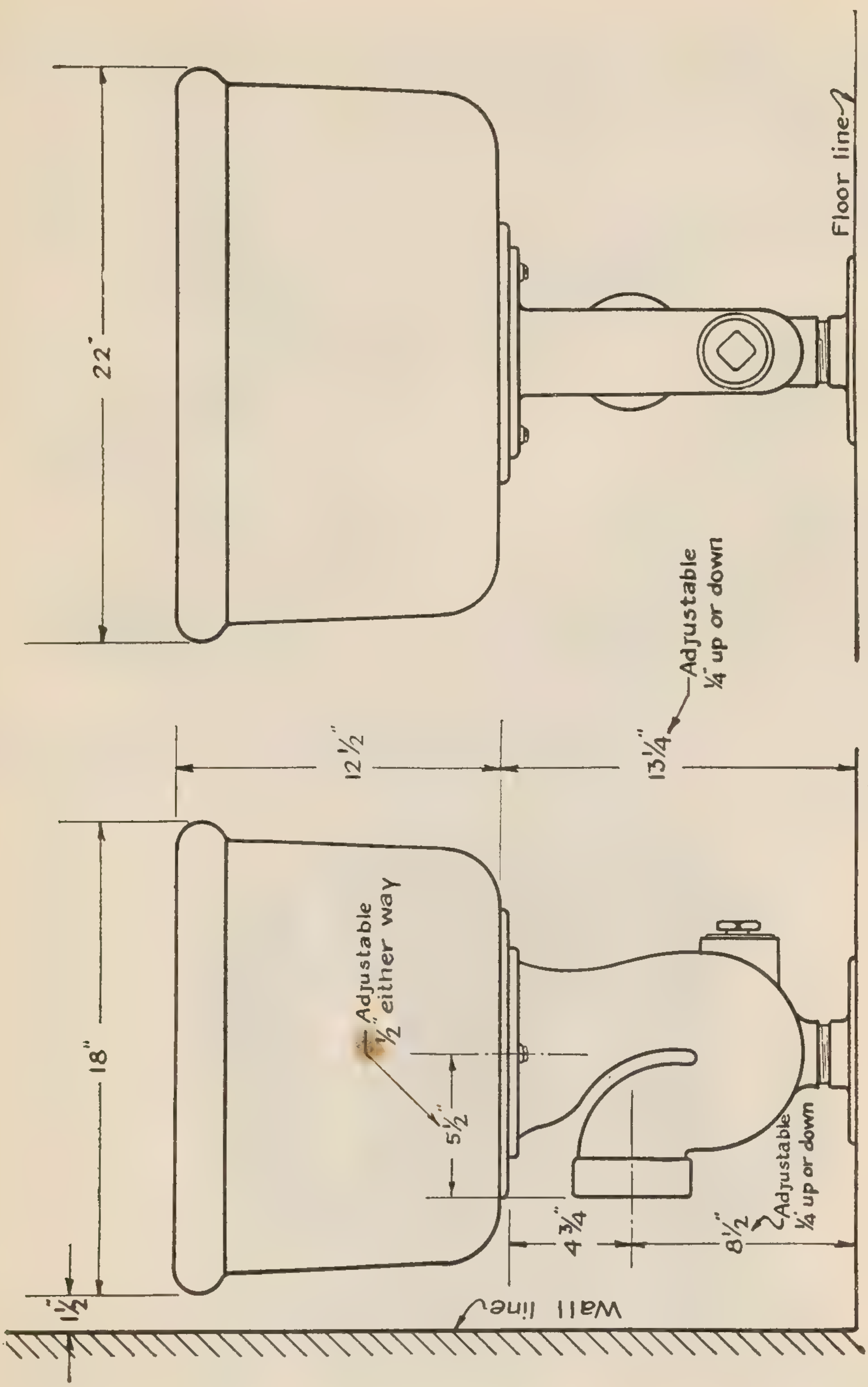
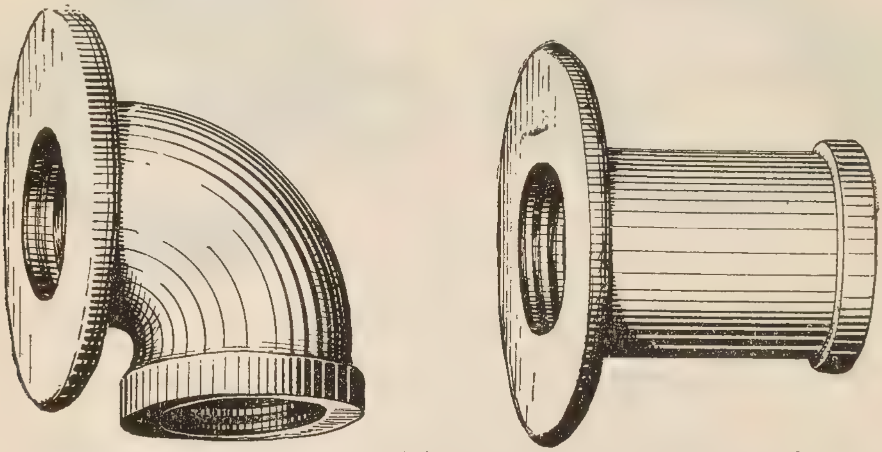


FIG. 7,670.—Mott cast iron water cooled grease trap.



FIGS. 7,671 and 7,672.—Maddock's "Madevin" white viterous china all roll rim slop sink, size 18×22 in. with iron enameled inside and outside, adjustable trap standard with wall outlet and cleanout plug, *n.p.* brass outlet strainer and plug connecting sink and trap standard. Fitted with ¾ in. female *n.p.* brass combination compression supply fixture with china indexed handles and supply nozzle with pail hook.

FIG. 7,673.—Sink gasket as used with threaded collar for wrought pipe connection.



FIGS. 6,674 and 7,675.—S and H, flanged sink fittings. ***These fittings*** are for use on supply pipes against the backs of kitchen sinks, slop sinks, laundry tubs, etc. It makes a rigid connection without the use of wood blocks, iron washers or tin straps.

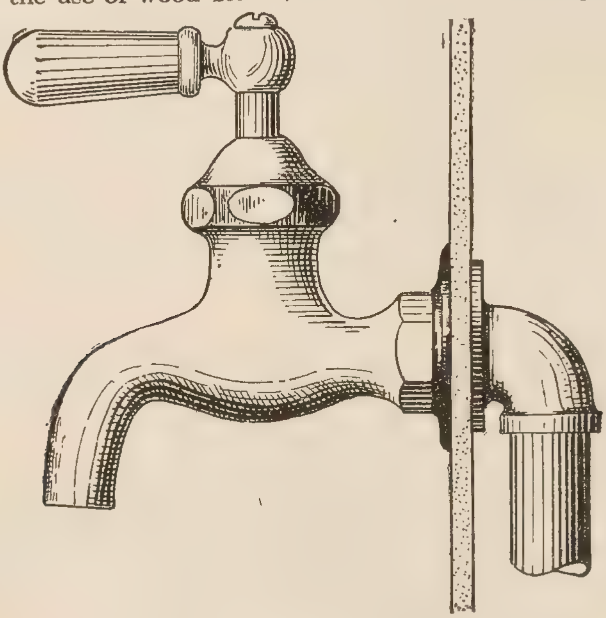
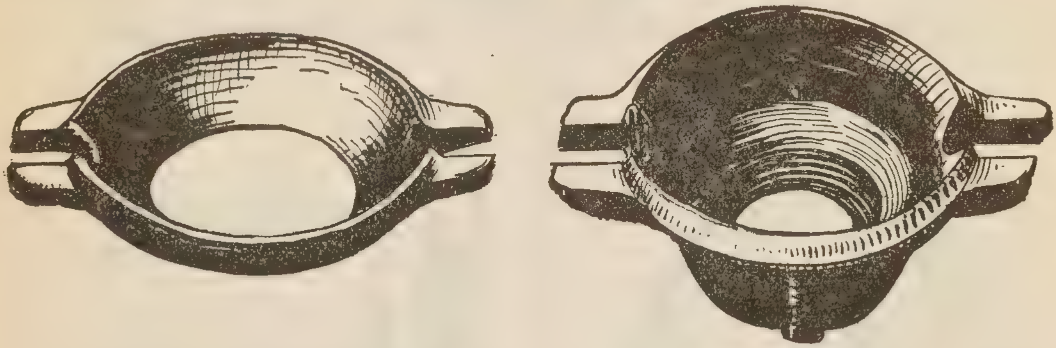


FIG. 7,676.—Application of S and H, flanged sink fitting showing elbow fitting on an exposed supply pipe back of kitchen sink. The straight fitting is used on a straight supply pipe from the wall. It is also used for supporting risers saving the use of an extra floor flange. Made in ½ in. size only.

and the shape of the rubber gasket used with the wrought pipe connection is shown in fig. 7,673.

Laundry Tubs.—Usually two or more tubs are provided for washing clothes as shown in fig. 7,679.



FIGS. 7,677 and 7,678.—Collars for cast iron sink connection. Fig. 7,677, plain for lead pipe fig. 7,678, threaded for wrought pipe.

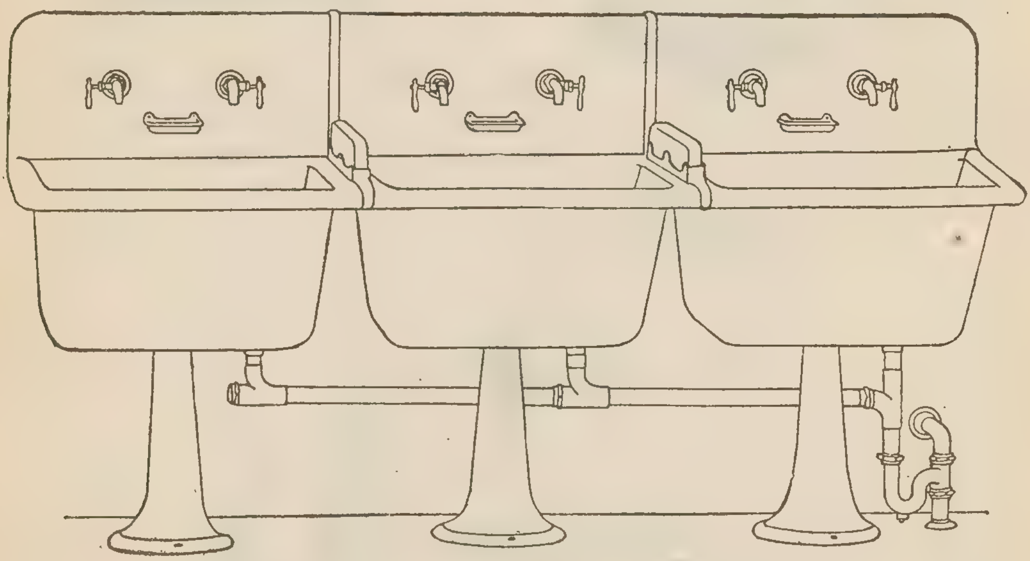


FIG. 7,679.—Typical set of laundry tubs with connections.

As here shown there are three tubs and when properly installed they are supplied with hot and cold water and are connected by a waste pipe to the drainage system. When located in a kitchen, laundry trays should be provided with covers to conceal soiled clothes when soaking, and to provide table space on top of the tubs.

In large apartment houses a general laundry is sometimes fitted up in the basement; when such is the case a single tub should also be installed in ezch of the apartments for the tenant to do light washing in.